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SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

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High-Fidelity Video Recording Using Ultrasonic Light Modulation

By LEO LEVI

The method described makes it possible to record electronic signals at video frequencies on photographic materials. Employing the modulation of light intensity by ultrasonic waves, the system is capable of resolution and dynamic range performance well in excess of that obtained with conventional methods. Both black-and-white and color modulation of light are possible. Ultrasonic light modulation has been successfully employed to obtain high-quality radar information, and it is inherently capable of providing a similar function in video recording — either field-by-field or continuous.

An interesting concomitant of high bandwidth video work is the problem of translating high-frequency information into a sensible form. A related problem is that of storing such information for viewing or extraction at a later date. The present paper describes a method of solving these problems, making possible high quality video recordings on photographic film. At the present state, this method makes possible the recording of video information with bandwidths up to 20 mc and, therefore, could be used for television recording.

A brief analysis of the problems involved will be followed by a description of the ultrasonic light modulation method and its application to video recording.

Problems in High-Fidelity Video Recording

Basically, video recording involves the conversion of high-frequency electronic signals into a form which is amenable to storage on the recording material. Basically, two approaches are used to perform this conversion—magnetic tape recording and light modulation in conjunction with photographic recording. The major disadvantages of the magnetic tape recording method are inherent in the high tape speeds required for recording information at 4- or 5-mc rates.

The alternative, light modulation, presents other difficulties. When electronic signals must be converted into a visible form at video frequencies, the only conventional method available employs a cathode-ray tube.

With this device, the intensity of the spot on the screen is controlled by varying the current in an electron beam in accordance with the electronic signal. This method is very convenient but, unfortunately, suffers from serious shortcomings. These shortcomings are in the nature of limited resolution and low dynamic range. The limitation in resolution is due to difficulties in focusing the electron beam. In practice, it is not possible to obtain much more than 1000 elements across a tube diameter with any appreciable contrast.

The limitation in dynamic range is inherent in the halation effects which accompany a cathode-ray tube display. Dynamic range is defined as the ratio of the maximum signal recorded (linearity specified) to the minimum signal observable. Now, if we measure a certain low light intensity on a spot of the cathode-ray tube display, we will not be certain whether there actually is a cathode-ray impinging on this spot or whether, perhaps, there is a very bright spot in the immediate neighborhood of the spot we are observing and it is merely halation effects which illuminate it. It thus becomes obvious that a relatively high signal intensity is required if the presence of signal is to be determined with certainty. In practice, the dynamic range of the cathode-ray tube is limited to approximately 15 to 1.

A further shortcoming of the cathode-ray tube display device lies in the lack of linearity. The response of a cathode-ray tube display is nonlinear to an extent somewhere between quadratic and cubic. In many applications this deficiency can impose rather serious difficulties.

The deficiencies of the cathode-ray tube type light modulator made it imperative that a new method of light modulation be developed which would make it possible to overcome the limitation in resolution, dynamic range and nonlinearity. The Ultrasonic Light Modulator was developed by the Fairchild Camera and Instrument Corp. to overcome the shortcomings of the cathode-ray tube.

The Ultrasonic Light Modulator

Ultrasonic light modulation is based on the diffraction of light at ultrasonic wavefronts (Fig. 1).

A slit in diaphragm D_1 is illuminated from the source S by means of condensing lens L_1. An image of this slit is formed on an opaque bar at D_2 by means of lenses L_2 and L_3. The bar at D_2 is slightly larger than the image of D_1 so that it

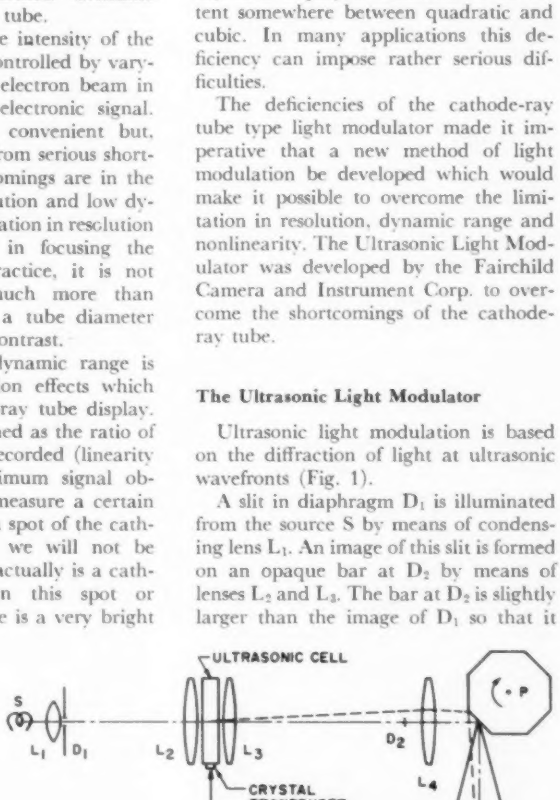


Fig. 1. Ultrasonic Light Modulator schematic.

Presented on April 24, 1958, at the Society's Convention in Los Angeles by Leo Levi, Fairchild Camera and Instrument Corp., 2 Aerial Way, Syosset, N.Y.
(This paper was received on April 17, 1958.)

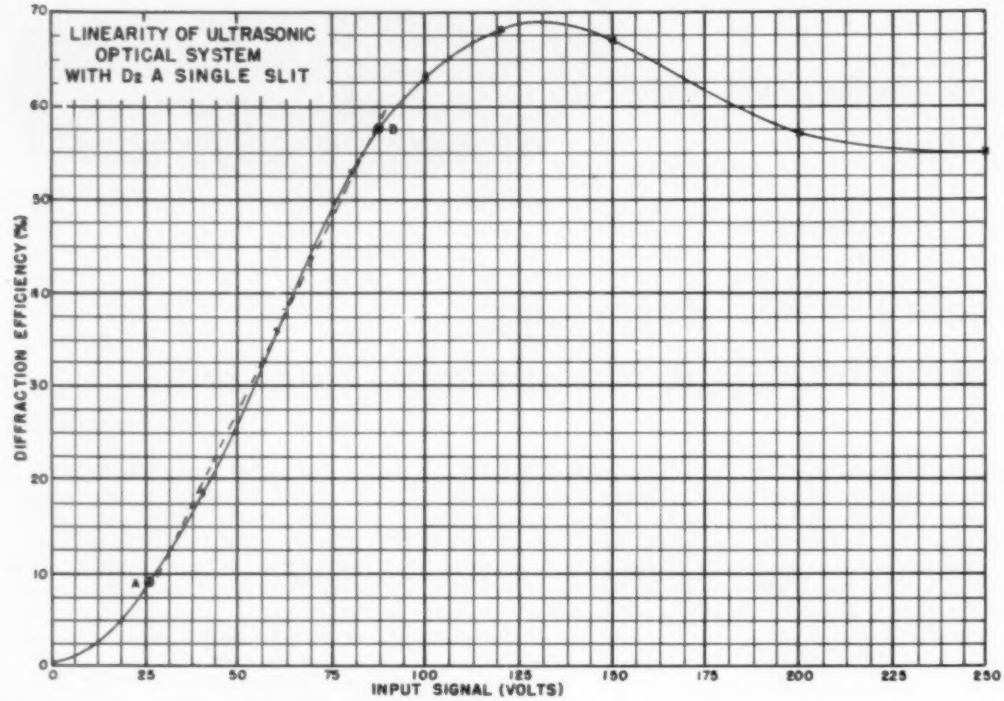


Fig. 2. Linearity of ultrasonic optical system with D_2 a single slit.

stops all the light that enters the system at D_1. The ultrasonic cell is placed in the collimated region between L_2 and L_3. A lens L_4 forms an image of this ultrasonic cell in the plane F after reflection from a mirror shown at P. Under the circumstances just described, the image shown at F will appear completely dark since none of the light illuminating the cell can pass D_2. When a signal is applied to the ultrasonic cell, light is diffracted around the stop D_2, as indicated by the dotted line. This light now passes D_2 and, as a result, the image at F becomes bright.

The operation of the ultrasonic cell may be understood from the following description. The cell consists essentially of a medium, such as water, in contact with a piezoelectric transducer. This transducer has the property of expanding or contracting when a potential is applied across it. When an alternating potential is applied, it will vibrate and thus send pressure waves down the column of liquid in contact with it. These pressure waves produce periodic variations in the refractive index of the liquid. Thus the portions of the incident light wave which pass through pressure troughs will be advanced in phase and those passing through the pressure peaks will be retarded in phase. As a result, a plane wavefront entering the ultrasonic cell at the left (Fig. 1) will leave it as a corrugated wavefront on the right, producing the diffraction grating effect.[1–4]

If now a short burst of carrier waves is applied to the transducer, a short train of pressure waves will travel down the ultrasonic cell. At F this will appear as a bright spot traveling the length of the cell image with a velocity corresponding to that of sound in the cell medium, as indicated by the arrow in the cell image shown at F. In order to make a recording of this spot of light, we may use either a very short exposure or make the spot stand still by rotating the reflector P. A rotation of the reflector in the sense indicated in the diagram will make the cell image move in the direction indicated by the lower arrow at F. If the velocity of this image motion is now made equal (and opposite) to the velocity of the pulse inside the cell, this pulse will have no net velocity with respect to the surface F, much as a man running down a railroad car will appear stationary with respect to ground when we move the car with the same speed in the opposite direction.

Incidentally, this scanning makes the total time interval recorded during one sweep independent of the cell length. The cell window length determines only the length of time the pulse remains visible at F, that is, the exposure time.

It can now be seen why the Ultrasonic Light Modulator does not suffer from the same resolution limitations as the cathode-ray tube display device. An almost arbitrarily small spot size, combined with an almost arbitrarily long scan line, makes it possible to obtain many thousands of resolution elements in a single scan line. The only limitations are those inherent in the photographic procedure—specifically, the resolution performance of the photographic material and the optical components.

So far, resolution has been discussed in terms of number of elements in a scan line. Resolution in terms of time will, of course, be limited by the bandwidth performance of the light modulator; but, since information bandwidths close to 20 mc have been obtained with the Ultrasonic Light Modulator, this limitation is not likely to be of serious nature.

Furthermore, in the Ultrasonic Light Modulator there are no halation effects analogous to those in the faceplate of the cathode-ray tube. As a result, the dynamic range performance of the Ultrasonic Light Modulator is extremely high. The limitations in dynamic range are again identical to those obtained in photographic recording, namely, scattering of light in the optical path and halation effects in the photographic material. As a result, dynamic ranges of several hundred to one have been obtained in field models of the Ultrasonic Light Modulator. In these models the spot intensity varied over a range from 200 to 1 as the signal intensity went from maximum to zero. In laboratory models considerably higher ratios are obtainable. It should be noted that the dynamic range of the light modulator is not limited by these values. Dynamic range is defined as the ratio of maximum signal recordable to minimum signal detectable in the recording. This min-

imum signal is limited not by the output level at no signal but rather by the fluctuations in this level, i.e., by the noise.

On this basis, the dynamic range of the light modulator itself should certainly exceed 1000 to 1. Primarily, limitations enter only in the signal-to-noise values maintained in the transducer drive system and in deficiencies of the recording material — the photographic film.

The linearity performance of the Ultrasonic Light Modulator is good. Figure 2 shows the response curve of the light modulator. It shows the diffraction efficiency as a function of input voltage for one ultrasonic light modulator arrangement. Diffraction efficiency here is defined as that percentage of the light entering the system at D_1 which goes into the formation of the final image and when approximately 125 v rms is applied to the transducer, the diffraction efficiency is close to 70%. The portion of the response curve between points A and B, corresponding to 9% and 58% diffraction efficiency, respectively, is linear within 2%.

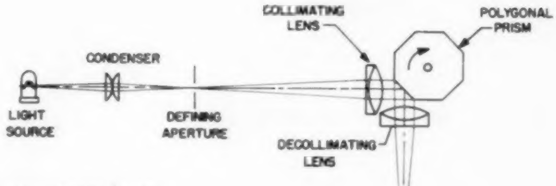
Application to Video Recording

The Ultrasonic Light Modulator (Fig. 1) may readily be adapted to video recording. If photographic strip film is placed in the plane of F and driven in a direction into the plane of the diagram with a speed sufficient to move the film the width of a single scan line during the period of a single scan, the film will be filled with transverse scan lines density-modulated in accordance with the signal intensities applied to the light modulator. In order to start the second scan immediately after completion of the first scan, a mirrored polygonal prism is used for the reflector, P. In order to maintain uniform light intensity across the full scan, it is, as a practical matter, preferable to use two polygonal prisms mounted coaxially, these sharing time equally. This enables the reflecting face of one polygon to completely enter and cover the scanning beam while the face of the other prism does the actual scanning.

This procedure will effect considerable economy of recording materials. For example, assuming that 4-mc information is to be recorded on 70mm film capable of resolving 30 lines per millimeter, a 1000-ft roll would accommodate considerably more than one hour of recording. This can be compared with one conventional method of magnetic tape recording in which 1000 ft of tape would accommodate less than 2 min of recording. There are other methods of magnetic tape recording which are somewhat more economical but which do not approach the economy of photographic recording.

These methods also use a scan transverse to the tape. In magnetic tape recording, the rotating component is no longer a simple prism spinning in air, but rather an assembly of magnetic recording heads which must be spun across the tape, in contact with it, at very high speeds. The alignment of these heads is very critical. On the other hand, due to the optical arrangement used, the tolerances on the position and angle of the prism faces are quite generous.

Fig. 3. Flying-spot scanner schematic.



These examples apply only to straight video recording. In recording television, it might be of interest to have the record in pictorial form. In order to obtain this, it is necessary only to synchronize the transverse scan with the line sync signal and to choose a film speed to yield the same scale for transverse and longitudinal scan. The recording should be similar to kinescope recordings but of higher quality.

Playback

The video recorder described in the first part of this paper will result in a photographic strip film containing density modulations which correspond to the electronic signals received. It then becomes necessary to convert these density modulations back into the electronic signals originally received. This conversion can best be accomplished by means of a flying-spot scanner. In this flying-spot scanner (Fig. 3) the image of a brightly illuminated pinhole is scanned across each recorded line on the film. The light transmitted by the film is made to fall on the cathode of a multiplier phototube. The output of the phototube will then be proportional to the transmissivity of the point on the film which was scanned. This transmissivity, in turn, will be proportional to the signal originally recorded if a linear positive film is used. In the event that a negative material is used, the output signal will be inversely proportional to the signal intensity originally recorded.

Light from a lamp is condensed on a pinhole and then collimated by a lens. It is then reflected from a rotating polygonal prism and refocused by another lens whose optical axis is perpendicular to that of the collimating lens. The film strip is placed in the focal plane of this decollimating lens and is followed by a "field lens" which images the reflecting prism face on the photosensitive cathode of a multiplier phototube.

In practice it may be possible to use either the identical recording instrument or a duplicate of it in the playback mode. It is only necessary to replace the ultrasonic cell in Fig. 1 by a point source of light and to place the field lens and phototube behind the film at F.

It should be noted that the playback speed need not be identical to the recording speed. The record may be played back either at a higher speed or, for close analysis, at a lower speed than the original recording.

Scanning Accuracy

Another great advantage of the proposed video recorder over both magnetic tape and cathode-ray recording lies in the great accuracies in scanning speed that can be obtained in recording and in playback. This accuracy potential is inherent in the type of scan and nature of the scanner as shown below.

One major difficulty in video recording is due to two conflicting requirements of the recording medium — the material must be flexible for storage purposes, but, if a uniform drive is to result, the material must be stiff. As a result, uniformity of scan speed is one of the major problems in accurate video (and audio) recording.

This difficulty is further aggravated by the substantial load that the drive mechanism must carry and by the correspondingly large torque fluctuations that are encountered as a result.

We shall now attempt to show how the proposed type of scan remains totally unaffected by minor speed fluctuations of the recording material and how an extremely uniform scanning speed may be attained with the proposed scanner.

The proposed scan is transverse to the direction of travel of the recording medium, say photographic film. The information is thus laid down in the form of lines (i.e., narrow strips) running transverse to the film strip, much as scan lines on a television screen. It is played back by means of a similar scan. Under these circumstances, the rate of scanning is obviously independent of the film velocity. Only if the error is sufficient to make the scanning spot skip from one information "line" to the next, will information be lost. Needless to say, mechanical tolerances close enough to prevent an error of such magnitude can

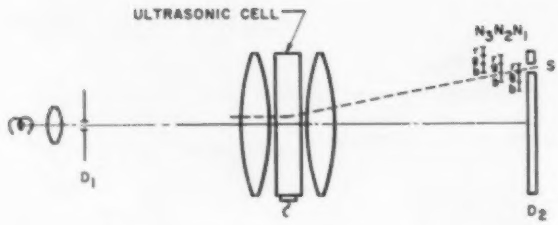


Fig. 4. Color modulation system.

readily be maintained. Cumulative, long-term errors can be eliminated by tying the scan to the film velocity by a closed loop (mechanical or electronic).

It remains to show that the scanning speed may be maintained to a very high accuracy.

By mounting the scanner on the shaft of a synchronous motor, driven from a crystal-controlled oscillator, the power supply frequency — and therefore the long-term motor speed — can be maintained constant to within one part in several million.

The motor speed is also subjected to short-term (within one revolution) fluctuations due to changes in load and supply torques. A quantitative analysis, given below, shows that these fluctuations may be reduced to the same order of magnitude.

The fractional change in scanner velocity is given by

$$\frac{\Delta\omega}{\omega} = \frac{\alpha t}{\omega} = \frac{\Delta T}{M} \times \frac{\Delta\theta}{\omega^2}$$

where the angular acceleration

$$\alpha = \frac{\Delta T}{M} = \frac{\text{torque fluctuation (net torque)}}{\text{moment of inertia}}$$

and the time of application of the torque

$$t = \frac{\Delta\theta}{\omega} = \frac{\text{arc over which torque is active}}{\text{angular velocity}}$$

For instance, in the successful breadboard of a video recorder the scanner rotated at 24,000 rpm. If a 2-in.-diameter disk, $1\frac{1}{2}$ in. high, of Mallory 1000 metal (S. G. 17), is used as a flywheel, the moment of inertia will be about 4235 g/sq cm. If we now assume a torque fluctuation of 0.45 oz-in.* applied over 10° of the rotation, the resulting fractional speed change is one part in five million.

This should also be compared with the scanning accuracy obtainable with a cathode-ray tube, where one part in a thousand is considered excellent.

One additional source of fluctuation of scanning speed is due to distortion in the objective lens focusing the collimated scanning beam on the film.† But, if identical objectives are used in the recording and playback modes, this error is automatically eliminated — the errors in the two modes can be seen to cancel.

It should be noted that — to maintain these accuracies — the plane of the recording medium must be held constant to the same tolerance.

* This value is about one-third of the total torque applied to the scanner, i.e., its friction and windage losses.

† The fact that the scanned distance is proportional to the tangent rather than the arc of the scanned angle can be considered part of this distortion.

Color Modulation

It may be of interest to note that inherent in the ultrasonic light modulation method is also the possibility of color modulation of light. As pointed out earlier, the ultrasonic cell is essentially a diffraction grating and, like a diffraction grating, it separates the incident light into its spectral component. The image of a narrow slit at D_1 (Fig. 1) will appear drawn out to a full spectrum in each diffraction image at D_2. If we now select one color from one spectrum (Fig. 4), the cell image will appear in that color.

If the frequency of the signal applied to the transducer is changed, the ultrasonic wavelength in the cell will change and the diffraction angle will be changed proportionally to the frequency change. As a result, the color light selected by the same slit at D_2, too, will change. In other words, the color of the cell image may be changed by frequency modulating the carrier signal applied to the cell, just as the brightness of the cell image is changed by amplitude modulating this carrier. It should be noted that a continuous change of hue is thus possible.[5]

Conclusions

The proposed method of photographic video recording employing ultrasonic light modulation is not only practical but also capable of high performance and great economy not achieved by more conventional methods. The system is relatively simple, requires no unusual mechanical or optical tolerances, and contains no particularly sensitive components. Several devices using ultrasonic light modulation have been successfully developed. Most of these are radar recorders and the results obtained are classified, but it can be said that they show striking improvements over standard radar recording techniques and have established the reliability of ultrasonic light modulation equipment in field use. The Ultrasonic Light Modulator should be a useful tool in video recording.

Acknowledgment

The author would like to take this opportunity to acknowledge the work of Dr. A. H. Rosenthal due to whose vision this program was initiated and who also contributed many of the basic concepts and that of Mrs. Sophie Tinto, whose original work in the development of ultrasonic transducers made possible the performance reported on in the present paper.

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Discussion

Rolf A. Seitle (*WTTW, Chicago*): In the application to television image recording, the original image, of course, has to have synchronization signals added to it and in the playback you will have to record the synchronization. Would this be accomplished by recording the synchronization signals in the same manner as the picture information, or how otherwise would you try to accomplish this?

Mr. Levi: Synchronization would definitely be a problem. One solution would be to use a very stable generator for the line frequencies. Used with a stable mechanical method of playback, this would maintain the short-term stability. For long-term stability you can use just the regular sync signal to make sure that the frequency roughly corresponds to the frequency of the recording. Again, in this case, the speed of the prism in the recording equipment at the time of recording must conform exactly to the speed of the playback.

To suggest an example, you might use the sync pulses to operate a multivibrator and to filter out from this multivibrator a sinusoidal wave which can be used to drive a synchronous motor, and, if these fluctuations are kept very low, this method should provide satisfactory synchronization.

Mr. Seitle: If they are recorded on the same film medium, would they be visible in playback?

Mr. Levi: Yes, they could be recorded as a track on the side.

Mr. Seitle: Has Fairchild made any attempt to use this unit as a commercial video recording system?

Mr. Levi: No. As I said, the only commercial application has been in radar recording.

Mr. Seitle: Are you planning to use it for video recording?

Mr. Levi: If there should be a demand for this type of recording, we'd certainly consider going into developing it.

Franklin D. Hood (*Tektronix*): There is another possible light modulation system — the Kerr type of cell. I understand that it has recently been developed by Baird Associates to quite a high degree of usefulness. Have you considered using this type of modulation instead of the ultrasonic?

Mr. Levi: Yes, we have certainly considered it. The reason for choosing the ultrasonic method instead of the Kerr cell was chiefly that using the Kerr cell requires extremely high voltages which create difficulties in military application.

Also, by choosing the ultrasonic light modulation method there is an economy in light. If you use a Kerr cell you can expose only one element for the period of that one element. For instance, if you're recording 4-mc information, you can record for possibly an eighth of a microsecond. With the ultrasonic method, you expose any element for the full period that it is present in the ultrasonic cell, which may be about 40 microseconds. So, in this example, there would be 320 times more light for a given light source than would be the case with a Kerr cell.

Mr. Hood: Could the same apparatus be used for a playback that is used for recording with a photocell located behind the film by removing the light modulator in the playback?

Mr. Levi: Yes. The only change would be to replace the ultrasonic cells by a point source of light and to have a phototube mounted behind the film. As a matter of fact, in one instrument that we developed for testing radar units, such a device was designed as a pushbutton conversion. A mirror was used which flopped into the light path, blocking out the ultrasonic cell and imaging a pinhole in its place. The multiplier phototube was permanently mounted behind the film. It served no function during recording and during playback it picked up the modulated light.

Hans Wohlrab (Bell & Howell Co.): I can confirm how excellent this ultrasonic system is. During World War II the German Air Force developed it for wireless transmission of air photographs and used it very successfully. In reference to the Kerr cell as a light relay, I worked on its development at the Leipzig University from 1923 on, as an assistant to Professor Karolus, who made its use possible for phototelegraphy and sound recording. But after many years of practical use, we preferred the ultrasonic light relay because of its higher efficiency and much simpler operation. After World War II, Professor Karolus used it for an FM sound-recording system with a 40-kc basic frequency and recording across the film similar to the Ampex Videotape System.

R. M. Morris (American Broadcasting Co.): With this ultrasonic transmission line in which you have several elements moving and stored at any one time, what do you do about terminating it to avoid reflection?

Mr. Levi: Termination has two requirements. It must match, acoustically, the medium itself, otherwise you're going to get reflection. It must also be highly absorptive of energy. With the ultrasonic medium that we use, it turns out that a certain neoprene serves both these requirements; we are using that as a termination in the lines and, to within a factor of 1000, there is no reflection from this absorber.

Robert G. Neuhauser (Radio Corp. of America): With a second drum to produce a second direction to scanning, is there good possibility of getting enough light through the system to use this as a television projection system?

Mr. Levi: The system has been used for television projection in England. It was known as the Scophony system and was successful, but not economically practical. I'm not certain of the exact reasons for discontinuing it, but it's not being used at present. The advances that we introduced were improvements in the resolution beyond the capabilities of ordinary television.

Mr. Seitle: Having the information recorded on the film as a negative does not make any difference as such since it can be inverted upon playback in an amplifier. However, if there is a possibility of making multiple prints, problems of distortion and loss of high frequencies due to image spread would have to be solved somewhat analogous to optical sound recording and printing, by cancelling this image spread in the print development. Is this correct?

Mr. Levi: Would you clarify your use of the terms "image spread and cancellation?"

Mr. Seitle: Image spread occurs in the development of a variable-area negative and causes fill-in of the high-frequency image. In the development of an optical print made from this negative, fill-in also occurs which helps to cancel such negative degradations. Since your process has many similarities to optical sound recording of the variable-area and variable-intensity type, but contains much higher frequencies, do you feel that it may be feasible to make prints from an original?

Mr. Levi: Certainly. As a matter of fact, this would remedy the inversion that you mentioned. You get your original film with the negative, but by printing and paying careful attention to the processing, maintaining your gamma of one, you've maintained your linearity and all your copy prints would be positive again; and you could use these positives in the playback.

Mr. Seitle: It would certainly call for new laboratory techniques in printing.

Mr. Levi: Why?

Mr. Seitle: The vertical resolution of a television imaging process is mainly limited by the number of scanning lines employed. In a normal photographic television recording using cathode-ray-tube photography, I have noticed that printer slippage in a continuous printer results in a noticeable degradation of vertical resolution in the print. In order to preserve the high original quality of your negative, even tighter control of the printing process would be necessary.

Mr. Levi: It would be the same. I don't know why it would be more serious. In either case you have to control slippage in order to maintain resolution. Any deterioration you get in your printing, of course, would show up in your final playback.

Ellis D'Arcy (D'Arcy Associates): How many bits of information per square inch can you obtain with your method; do you happen to have that information?

[Reply in detail supplied in writing:

[*Mr. Levi:* The information density, in bits, is given by $C = \frac{1}{a} \log_2 N$, where a is the area of one information element and N is the number of discernible gray steps. It can be shown* that N, as limited by granularity, is given by

$$N = \frac{\sqrt{a}}{2\sqrt{2}} \frac{\Delta D}{G}$$

where ΔD is the overall linear density range available from the emulsion and G is the Selwyn granularity.

[On the basis of $G = 1.5$ (corresponding to Eastman Super XX film), $a = 0.00028$ (corresponding to 30 line pairs per mm) and $\Delta D = 2.5$, N is found to be 9.44. This would make the information density $C = 11{,}700$ bits per sq mm.]

[In practice, halation effects in the emulsion will lower this figure, which is based on granularity alone, so that one can say safely only that the information density is somewhere between 3,600 and 11,700 bits per sq mm (between 2.3×10^6 and 7.5×10^6 bits per sq in.).]

Walter Bach (Berndt-Bach, Inc.): I would like to make a brief statement on printing and slippage. About 25 years ago, E. W. Kellogg of RCA presented a paper on "Non-Slip Printers for Sound Track," and in New York we spent a number of years developing nonslip printers for optical soundtracks on 16mm. These completely eliminate slippage, even though the negative is shrunk and the positive isn't. We were able to print up to 10,000 cycles 16mm soundtracks with no degradation on the prints whatsoever. Precision Film Labs. in New York used these printers for a number of years.

*Leo Levi, "On the effect of granularity on dynamic range and information content of photographic recordings," *J. Opt. Soc. Am.*, *48:* 9, Jan. 1958.

Magnetic Recording Media Considerations for Improving Masters and Dubs

By RUSSELL J. TINKHAM

Optimum results from a magnetic recording-reproducing chain can be achieved only if the equipment is adjusted to take full advantage of the capabilities of the magnetic media available. Proper adjustment presupposes knowledge of those capabilities. The paper discusses the relationships of recording level, distortion, optimum bias, signal-to-noise ratio and their effects on the final reproduced signal.

Manufacturers of magnetic recording equipment frequently receive complaints that a machine does not meet specifications, that it makes noisy recordings or that promised, or expected, results have not been achieved. There is a modicum of truth in some of these statements, but more often such comments are based on a lack of understanding of the basic principles involved in the magnetic recording process and a lack of knowledge of how to apply these principles in the production of top-quality magnetic recordings on film and tape.

The magnetic recording process is sometimes oversimplified. The user may believe that the only requirement for a good recording is to place a reel of tape or film on the recorder, push the START and RECORD buttons and feed a signal to the microphone. When the system, during playback, does not yield what he considers a reasonable facsimile of the original sound, he assumes that the machine is inferior. The operator seldom recognizes that the deficiency could be the fault of the recording medium, or of the machine's being poorly adjusted, or that the fault might be in the operator himself.

Certain subjective factors contribute to the operator's disappointment. For example, if he should listen today to an early Edison cylinder, even after making allowances he would still feel that it should be better. As time goes on, listeners become more critical of recording techniques. Competitive pressure brings about continuing improvement of the product. One manufacturer may improve the recording process and, for a while, capture the market, but his competitors soon overtake him with as good a product, or outstrip him with a better system or equipment.

Tape recording for making masters and microgroove cutting have gone hand in hand to create the biggest boom the recording industry has ever had. Magnetic film recording has, without question, improved theater sound quality. Magnetic recording for mastering had the immediate advantage of providing an erasable, reusable, editable medium. For the performer, these magnetic recording features meant a relaxed performance. No longer is the artist under pressure to make a completely flawless performance. No longer does the operator, during the mastering, need to worry about dull-cutting styli, or wax playbacks, or hard spots in the instantaneous lacquer disk. He now has other problems, problems of which he may be only dimly aware but which are fundamental to achieving good quality on tape or film.

Presented on May 3, 1957, at the Society's Convention in Washington, D. C., by Russell J. Tinkham, Ampex Corp., 934 Charter St., Redwood City, Calif. An earlier version was presented September 26, 1956, at the Eighth Annual Convention of the Audio Engineering Society in New York, and published in the *AES Journal* for April 1957.
(This paper was received on March 30, 1957, and in final form on July 3, 1958.)

Master Recording Quality

What constitutes good recording quality in this "mid-morning era" of magnetic recording?

A good master is characterized by:

(1) Low distortion;

(2) High signal-to-noise ratio;

(3) Wide and uniform frequency response; and

(4) Freedom from mechanical problems.

Any recording system, whether tape, wax or film, will tend to distort if overloaded; therefore, to minimize this problem, the recording level should be reduced, and conversely, all recording systems inherently have noise, so to minimize this, the recording level should be increased.

Frequency response suffers at low tape speeds so, to compensate, the operator should either speed up the tape or pre-emphasize the higher frequencies. Since good magnetic recording heads are expensive, the tape or film speed should be slowed down so that the heads will last longer.

We find ourselves facing a many-sided problem. It is necessary to make a series of compromises in building a magnetic recording system. We must consider the speed of the recording medium, the frequency response, distortion, flutter and wow, the chemistry and physics of the recording medium itself, and the relationship of each of these to each of the others.

Successful compromises in magnetic recording have led to a quality of reproduction which meets or exceeds these overall specifications:

(1) Distortion, 1% harmonic, measured at 400 cycles;

(2) Signal-to-noise ratio, 60 db;

(3) Frequency response, 40 to 15,000 cycles ±2 db; and

(4) Flutter and wow, 0.05%.

These specifications can be achieved if everything works correctly, which is to say if the machine is in good working order; the tape or film of satisfactory quality; and, most important, the machine adjusted to match the recording medium used.

This last point should be emphasized. There is an obvious implication here: recording tapes and recording films are not all the same. Even tapes or films from the same manufacturer will differ from batch to batch.

Causes of Poor Quality

The failure to achieve a satisfactory master may be due to any one of a number of causes or to a combination of these causes:

(1) Poor or damaged microphone;

(2) Harmonic distortion, frequency distortion, or noise introduced ahead of recorder;

(3) Mechanical maladjustments or damage to the recorder;

(4) Improperly aligned recording system — (a) incorrect head azimuth alignment, (b) improper recording equalization and/or playback equalization, (c) incorrect bias adjustment;

(5) Magnetized heads;

(6) Improper recording level (either too high or too low);

(7) Unsatisfactory recording medium — (a) dropouts, (b) inherently poor frequency response (too "hot" or too "cold"), (c) mechanical faults such as the coating flaking off, high friction, curl, or improper slitting or coating.

This discussion will be confined to the intimate relationship between the recorder and the recording medium itself.

It should be assumed that any mechanical or electrical maladjustments have been detected and corrected but too often it is found that an improper diagnosis has been made and incorrect measures taken to remedy such malfunctions. It is well to double-check anything that is suspected. The operator should be familiar with the basic alignment procedures usually described in instruction books accompanying professional-quality recorders. Unfortunately, however, most complaints about poor operation of equipment result from incorrect alignment proce-

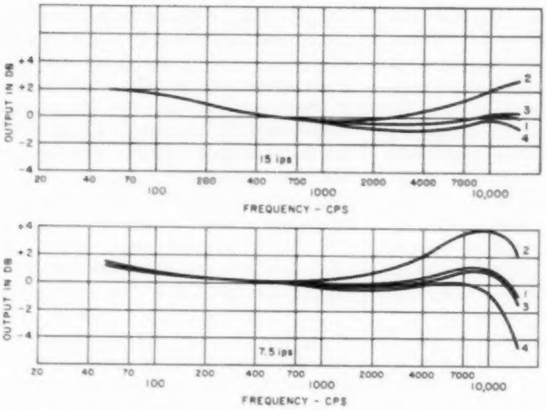


Fig. 1. Frequency response of four tape samples, holding bias and input level constant.

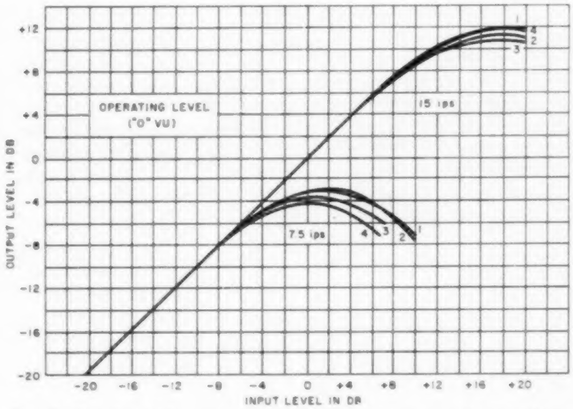


Fig. 2. Overload characteristic of the four tape samples at 10 kc, bias constant and input varied.

dures on the part of the operator. Professional recording machines are purposely made adjustable so that optimum quality recordings may be secured, but any maladjustment will lead to exactly the opposite result. A good tape recorder or film recorder, like a racing car, can be tuned to a fine peak of performance, or it can be de-tuned so miserably that it limps along.

Proper Adjustment

First of all, in the interest of standardization, it is well to remember that in seeking a correct presentation of the recording, a good *playback* of the previously recorded track is required. This means that the playback on all reproducers should be the same. This also means that any variations in machines, tapes or films, or methods of recording, should be compensated for in some manner before running the recording medium past the playback head and through the playback amplifier. Any given system should be standardized so that the playback section has a standard head azimuth alignment, acceptable flux density on the tape (i.e., proper recording level), and uniform frequency response.

After the playback section has been standardized, the next consideration is to modify the recording section to yield the proper type of pattern *on the recording medium* so that it will play back properly. This seems obvious, but many operators either overlook this or are unaware of it. Most factories producing tape and film recorders have some sort of checkout procedure which includes playing a standardized section of film or tape. Professional machines are usually adjusted to the average material available on the market at the time of manufacture.

Variations in Recording Materials

Although a checkout procedure uses an average piece of the recording medium, it must be recognized that the various manufacturers of such material have different oxides, use different binders to secure the oxide to the base, or use different manufacturing methods to produce tapes or film. Obviously, differences in the several characteristics of the recording medium obtained from different manufacturers may be expected, but professional machines are sufficiently adjustable to compensate for these differences.

It must also be recognized that tapes or films of any given manufacturer may vary somewhat from lot to lot within reasonable and normal manufacturing tolerances. There may also be a slight shift from year to year, and, of course, a manufacturer may gain some current advantage over his competitors by bringing out a new coating which may be markedly different in its inherent characteristics. This poses additional problems for the manufacturer of equipment and the consumer.

All tapes and films vary in one or more of the following characteristics:

(*1*) *Electrical:*
- (a) Bias point;
- (b) High-frequency response;
- (c) Distortion (throughout the passband);
- (d) Overload characteristic (throughout the passband);
- (e) Variations in frequency response or in bias requirement, due to uniformity (or lack of it);
- (f) Signal-to-noise ratio;
- (g) Sensitivity;
- (h) Remanence.

(*2*) *Physical:*
- (a) Abrasiveness;
- (b) Coefficient of friction;
- (c) Adhesion of oxide to base;
- (d) Dropouts (electrical or mechanical).

For home entertainment, variations between tapes are usually insignificant. This does not hold true for the professional. For this critical group, who must often make second, third, and perhaps even further generation copies, it becomes a virtual necessity to effect the best possible relationship between the recording medium and the machine upon which it is used. A good relationship between recorder and recording medium can be achieved by following a series of steps for any given reel of the recording medium.

Differences in Magnetic Coatings

Four samples are used to show possible variations in magnetic coatings. The samples have been carefully selected to illustrate certain points, but are "random" in that they are from different reels, from different localities, from different manufacturers, or were produced at different times.

Figure 1 shows how these four samples perform under the same conditions. The bias adjustment of the recorder and the input level were set at optimum average and left that way. The variations shown in the curves are frequency responses inherent in various samples of the recording media themselves. Some are "hot," some are "cold." There is more variation at slower speeds than at higher speeds, as might be expected.

Figure 2 illustrates overload distortion. The curves show how these same four coatings overload at 10 kc. The bias setting has not been changed from the conditions illustrated in Fig. 1. This is a graph of "output vs. input," where the input level was varied. Overload was affected by the normal high-frequency pre-emphasis in the record amplifier. This is the same, however, for all four samples. Note the difference between slower speed and higher speed. The playback equalization was the same for both.

It is especially to be noted here that the "operating level" line is considerably above the overload values for these samples at the slower speed. It must be borne in mind that: (1) these curves are for 10 kc; (2) pre-emphasis in the

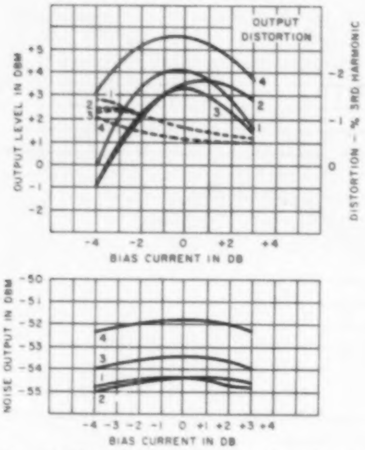


Fig. 3. Distortion (broken lines) and output in the four tape samples vs. bias changes (upper curves); and background tape noise vs. same bias changes (lower curves). Signal-to-noise ratio vs. bias settings may be read directly.

recording amplifier amounts to 16 db at $7\frac{1}{2}$ in./sec, and 6 db at 15 in./sec; and (3) this pre-emphasis is entirely legitimate when one considers the energy-distribution curves for music established by Bell Telephone Laboratories.

Figure 3 (upper part) shows the effects of changing bias on these same four samples. The lower speed was used, at a frequency of 500 cycles/sec. The input level was held constant. The "hump-backed" curves show output level for changes in bias. The simultaneous effect which an increase in the bias current has on the reduction of the third harmonic distortion is shown by the dotted curves sloping downward to the right. Second harmonic distortion in a properly designed magnetic recording system is negligible and may be disregarded.

Figure 4 is concerned with only one of the four samples and shows what happens to frequency response when the bias is varied. As the bias current is raised, the high-frequency response deteriorates. The changing of bias is one way of adjusting the high-frequency response characteristic within certain limits. If the bias adjustment is used for making an equalization change, its effect upon distortion must be considered.

Figure 5 shows what happens to distortion at 500 cycles/sec as the output level is changed. This curve is characteristic for all magnetic recording media.

Returning to Fig. 3, the output levels and distortion for the original four samples may be noted at the top, and then at the bottom there may be noted what happens to the background noise as the bias is changed. Since the ear is more aware of hiss than hum, a 200-cycle high-pass filter has been used in making these curves.

Figure 6 shows the usable range of these four samples. The bottom end of each bar is the practical background noise level inherent in the recording media. The top end of each bar is the 1% harmonic distortion level (using 500 cycles). This shows that if one makes a recording on tape sample 4, for example, where peaks hit "zero" on the meter, one may sacrifice as much as 3 db in signal-to-noise ratio, since one could record at a 3 db higher level before reaching the 1% distortion point. Tape "X" is a sample from behind the Iron Curtain, presented here in the interests of comparison.

From the typical data shown in the figures, one can draw some fairly definite conclusions about getting the most out of recording media.

It is obvious that a tape speed of 15 in./sec or a film speed of 18 in./sec (96 ft/min) is best in consideration of overload distortion and uniformity of frequency response. It is obvious, also, that optimum bias will give best results. But even here, it is possible to juggle a higher bias current for less distortion on a piece of magnetic recording material possessing a very good high-frequency response.

Last, and probably most important, is the signal-to-noise ratio. At the normal mastering speeds, we have the best overload condition with respect to a higher input signal. Some operators record 3, 5, 7, and even 10 db below normal indicated "zero" recording level to keep the distortion down. In the opinion of the author, however, these operators penalize themselves needlessly. On one well-known make of recorder, zero on the meter is adjustable to a 1% harmonic-distortion level for the average of all recording media currently available. The 3% harmonic-distortion level, which can be inferred from the curves shown here, is 6 db above this point.

It is questionable whether this propensity for recording below zero level is justified. This practice may be due to timidity. Since all magnetic recording is a compromise, it can be shown that on magnetic recording materials the same sharp breakover into the overload conditions does not obtain as it does in optical recording. The overload condition on peaks in magnetic recording is more like compression.

Demonstrations

When this paper was presented, a series of demonstration tapes was played. An original recording of an internationally famous orchestra was used as a basis of comparison. A one-to-one copy of the original master at the normal recording level was made and presented to form the basis of comparison between the original and the first copy. A second dub from the master, made at 6 db higher than normal recording level, was then presented for further comparison. A compensating decrease in the overall volume control setting was made so that the acoustic level within the room was the same as the original. Overload conditions on the peak levels of percussion, etc., were not objectionable to those present. Another dub of the original made at 6 db lower than the normal recording level was then pre-

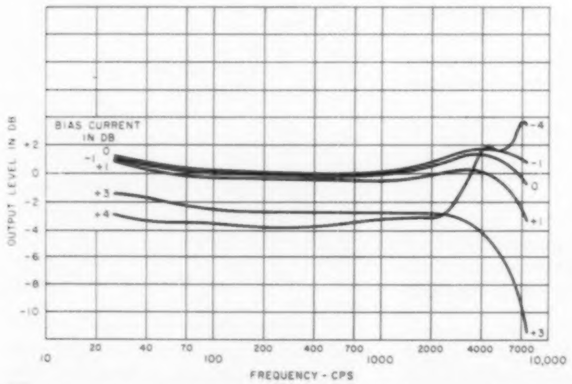


Fig. 4. Variation in frequency response (using a typical tape sample) resulting from changing bias current; output reference level, −20 dbm.

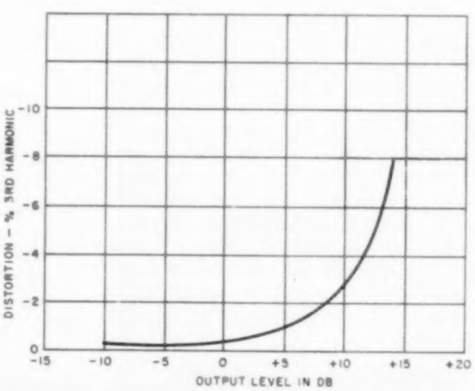


Fig. 5. Distortion vs. signal output (using a typical tape sample).

sented. A compensating increase in the playback channel gain was made to maintain the acoustic level. A noticeable increase in background noise was evident.

The marked change in signal-to-noise ratio between these various copies and the original indicated that it may be better to record at higher levels than has been customary.

Conclusion

It is axiomatic that differences exist in the electrical and physical characteristics of the many magnetic recording media.

To achieve optimum results, the recorder must be adjusted to match the characteristics of the recording medium. Professional recorders may be adjusted in the following manner and in the following sequence:

(1) Adjust the playback section for uniform frequency response and level, using a known standard of comparison (such as an accepted "standard" film or alignment tape);

(2) Adjust the bias, using the proposed recording medium;

(3) Adjust the recording equalization to yield a flat overall playback from the previously adjusted playback system; check this at least 10 db below normal recording level when using tape at 15 in./sec or film at 96 ft/min to avoid high-end overload due to the usual pre-emphasis;

(4) Check the recording level, and keep it as high as practical in view of both signal-to-noise ratio and overload considerations.

The best results will be achieved by selecting the recording medium which gives the best frequency response with the lowest distortion, and by adjusting the bias to achieve this balance.

Good signal-to-noise ratio will be achieved by recording a sufficiently high level, as the overload characteristics of magnetic tape and magnetic film, fortunately, are gradual rather than abrupt.

Finally, because of the fact that the many recording media on the market differ in sensitivity, as shown in Fig. 6, it may be concluded that the master recording should be made at various levels, depending on the characteristics of the medium used. The recording gain control then becomes a useful component in the system.

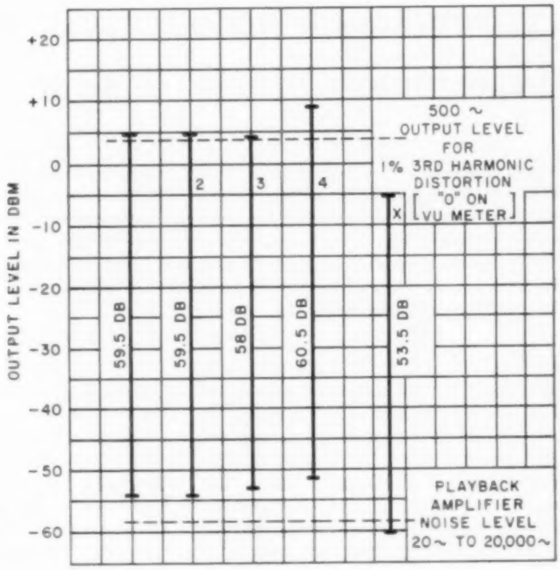


Fig. 6. Output level at 500 cycles for 1% harmonic distortion.

Acknowledgments

The author is indebted to Harold V. Clark, Engineer in charge of the Ampex Standard Tape Laboratory, for running the data on the hundreds of tapes and films from which the "random selection" was taken; and to John Leslie, Chief Engineer, Audio Division of Ampex, for his helpful suggestions on arrangement of the data.

Discussion

John Arvonio (Photo-Magnetic Sound Studio, Inc.): Are you aware that the azimuth on your multifrequency test reel for Ampex and the azimuth track given for the Fairchild machines are not exactly the same?

Mr. Tinkham: This has not previously been brought to our attention. The method that we use in arriving at our azimuth alignment consists of approximately a three-step arrangement. We use a tape machine designed for making standard tapes and we align the head to what we believe to be vertical with respect to the motion of the tape, and make a 15,000-cycle recording at 15 in./sec. We then use the printing method of transferring that frequency to another piece of tape with a high-frequency bias signal. The two pieces are brought together, oxide to oxide, and run through the bias field simultaneously, so that a printed mirror image of the original signal is obtained. If you were to take the original tape and turn it end for end, you would, of course, have done nothing about the alignment which maintains its constancy because of the old vertical angle theorem in plane geometry. We take the printed mirror image of the original alignment, and play that through the same machine over the same head. If there is a difference in level, caused by gap misalignment, the head can be adjusted in one direction or the other until we "split the difference." Two or three such successive approximations may be necessary to secure the required accuracy.

Mr. Arvonio: Would you know if the Society is planning to make a standard azimuth track for tape machines?

Ellis W. D'Arcy (Session Chairman): The Society produces a standard azimuth film for motion-picture film but not for tape machines. It has not as yet been considered. Such a film might be of use in connection with perforated ¼-in. tape which seems possible for motion-picture production.

A Versatile Photographic Recording System for Studio Use

By G. A. BROOKES
and H. A. MANLEY

A variable-area or density photographic recording system has been designed with optional magnetic recording facilities. A short cabinet, containing transmission equipment of new design, and an associated table and recorder form a compact operating unit. The recorder provides a simplified film path for photographic and magnetic recording, improved optics and a novel visual monitor. Of particular interest are transistorized monitor amplifiers, simplified exposure meter and an improved compressor-amplifier.

Because of the emphasis which has been placed on magnetic recording by the motion-picture industry during the past decade, very little attention has been paid to the improvement and modernization of photographic recording systems. Since the photographic medium is still employed for the large majority of release prints for both 35mm and 16mm films it appeared worthwhile to develop a system which would incorporate many recent engineering advances and at the same time make a fresh evaluation of the facilities required in the light of current techniques and practices.

The system described is designed primarily for use as a transfer channel for either variable-area or variable-density application, employing either 35mm or 16mm film. Although electrical transfer is the prime function, it seemed advantageous to provide an installation suitable for small studios which could include also magnetic recording and monitoring facilities, and these features are available for use with either 35mm or 16mm magnetic film. For versatility in small studio application, it may be necessary for the system to be used with a remote mixer as part of a recording or re-recording channel and any one of several mixers is available for these purposes.

General Description of System

System Equipment

A typical 35mm system comprising a transmission cabinet, recorder and table is shown in Fig. 1. In this application, the table and recorder are shown to the right of and attached to the cabinet, although flexibility of design allows for various selections of location for the table and recorder relative to the cabinet. Each combination provides an integrated assembly with all controls within easy sight and reach. The top three rows of equipment in the cabinet are units which contain the meters and major operating controls. The less complex are terminal-strip connected and the remainder are provided with plug connections to facilitate maintenance procedure. Beneath these units is a blank hinged panel behind which are located subsidiary controls provided in connection with filter circuits and magnetic recording and monitoring facilities. The bottom three units are system power supplies and sufficient spare power is available for the operation of a small recording mixer.

The recorder is designed to record various combinations of direct-positive, negative, standard and push-pull track on 35mm and 16mm film. Various types of motor and motor drive are available for interlock and synchronous operation from either 50- or 60-cycle supply. The front section has two hinged doors for the separate film and modulator compartments and beneath the latter is the motor control panel. The rear section of the recorder contains the motor, motor-drive mechanism, monitor amplifier and various other items of transmission equipment.

Block Schematic

The simplified block schematic circuit of the system is shown in Fig. 2. Solid lines indicate the equipment and interconnections provided for the basic 35mm variable-area or variable-density transfer channel. The recording input circuit is connected to the input of the compressor amplifier through a test jack and an input attenuator which permits adjustment of the input level to compensate for widely differing signal-source levels and also allows adjustment of the operating point of the amplifier. Connected also to the input of this attenuator is a 400-cycle test oscillator, the frequency of which is adjustable about its nominal value in order to obtain a standing image on the visual-monitor viewing screen in the recorder. A slating-talkback microphone is connected across the output of this attenuator.

The compressor-amplifier is followed by high- and low-pass filters and each is provided with a switch for removal or

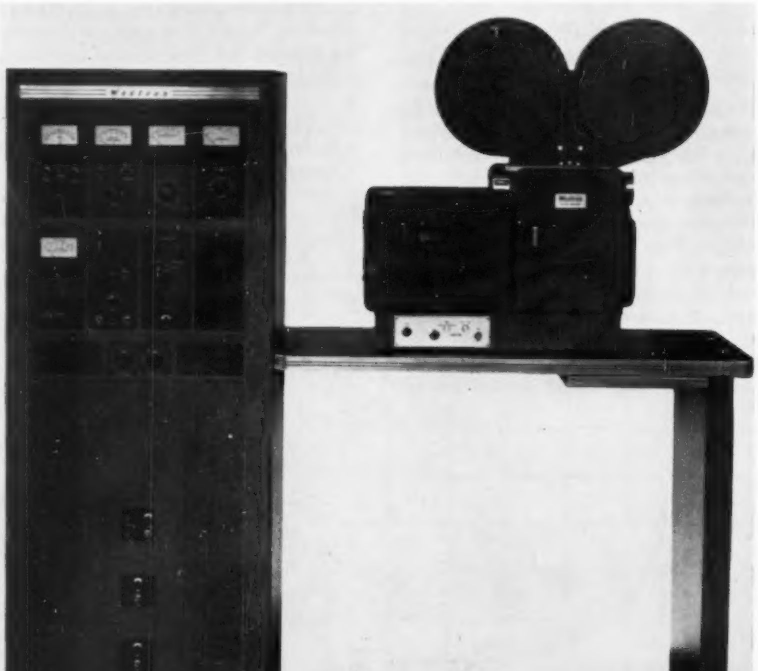


Fig. 1. Westrex 935-A system including transmission cabinet, recorder and table.

Presented on April 22, 1958, at the Society's Convention in Los Angeles by G. A. Brookes (who read the paper) and H. A. Manley, Westrex Corp., 6601 Romaine St., Hollywood 38.
(This paper was received on May 13, 1958.)

insertion as desired. Across the output of the filter circuits are the volume indicator, range switch and the local and remote direct-monitor circuits. A following output attenuator in conjunction with the input attenuator controls the operating point and overall gain of the amplifier.

The light-valve equalizer is provided with a pad which may be strapped for various values of insertion loss to compensate for the resonant rise of any one of the current types of Westrex light valves. The output is connected to the light-valve circuit in the recorder through either terminal strip or plug connections.

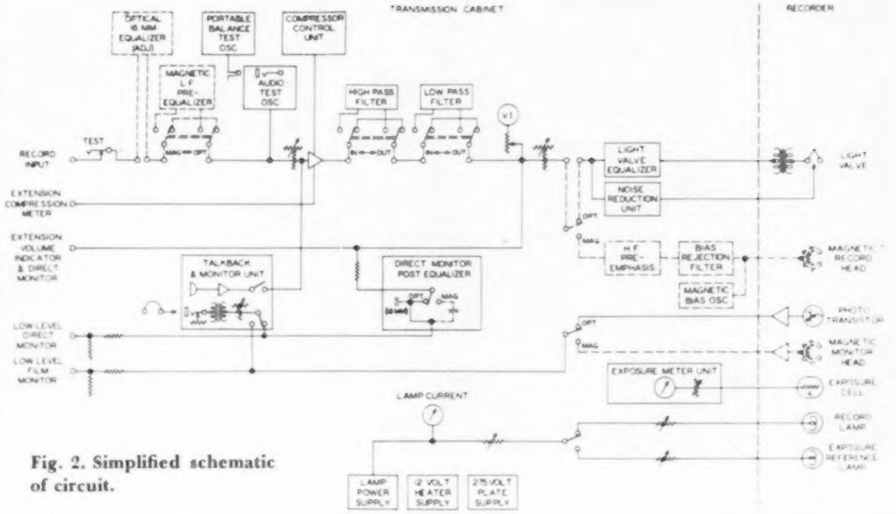


Fig. 2. Simplified schematic of circuit.

The noise-reduction unit is bridged across the input of the light-valve equalizer and is intended for use for push-pull or single-track and either variable-density or variable-area applications.

The monitor amplifier, of the transistor type, is located in the recorder and the output is used for a headset-monitor circuit in the transmission cabinet and extension to a remote monitor amplifier and loudspeaker. Both direct and film monitor are available at headset level in the transmission cabinet.

Recording-lamp, reference-lamp, and exposure-meter circuits are shown and are employed together in a novel manner in the variable-area systems to maintain a constant value of record-lamp exposure without resorting to frequent lamp-current and exposure tests.

The items indicated by dotted lines are optional accessories which may be installed in the transmission cabinet and the recorder in a very simple manner. The first unit, which is a 16mm equalizer, permits an adjustment of high-frequency boost and low-frequency droop, and the characteristic introduced is used in conjunction with the high-pass, low-pass filter combination to obtain the desired overall response. The second unit which provides high-quality magnetic-recording and monitoring facilities introduces low-frequency pre-equalization ahead of the input attenuator and conventional high-frequency pre-emphasis, bias-oscillator and bias-rejection circuits. The optional assemblies for the recorder comprise the magnetic record and reproduce heads and the magnetic-monitor amplifier which is of the transistor type. Operation of an "optical-magnetic" switch in the transmission cabinet results in the selection of the output of either optical or the magnetic monitor amplifier, and sets up the correct type of circuit for either the photographic or magnetic recording application.

Components of Transmission Equipment

Compressor-Amplifier and Control Unit

The recently developed compressor-amplifier has a number of new features and gives excellent overall performance. The compressor-amplifier comprises two units. The first unit is the amplifier and control-amplifier subassembly and the second is the associated control unit. Figure 3 is a front view of the latter unit. Although the two are in close proximity in this application, it is possible for them to be separated by 25 ft or more in other types of installation. For example, in a re-recording console the amplifier may be located within the unit and the control circuits on the main panel.

General features which are incorporated are those of adjustable-compression slope and threshold with peak chopping at the end of the compression range, a high degree of balance stability against thump, low distortion even on the compressed characteristics, and de-essing equalization. One distinct advantage is that almost any pair of tubes of the correct type may be used in the push-pull variable-gain stage and adjusted for balance without having to resort to a matched pair. The gain of the amplifier is 68.5 db and the frequency characteristic is flat within ± 0.5 db from 50 to 15,000 cycles. The distortion is less than 1% with or without the introduction of compression, up to a maximum output of approximately $+28$ dbm at which level peak chopping occurs. The output noise level is approximately -50 dbm in the uncompressed condition.

Figure 3 shows that front-panel control is given of either flat gain or various compression and limiting characteristics, release time and de-essing equalization. Two compression slopes are available, 2:1 and 3:1; the former over input ranges of 10, 20 and 30 db, the latter over input ranges of 10 and 20 db. The limiting slope is 10:1 and either a 10- or 20-db input range may be selected. Figure 4 depicts the various characteristics which are provided and it should be mentioned that other compression slopes and threshold values can be made available by very simple changes. Release time may be selected at either 100, 250 or 500 msec, and the de-essing equalization may be set at any value from 0 to 10 db. The attack time in all cases is less than 1.5 msec.

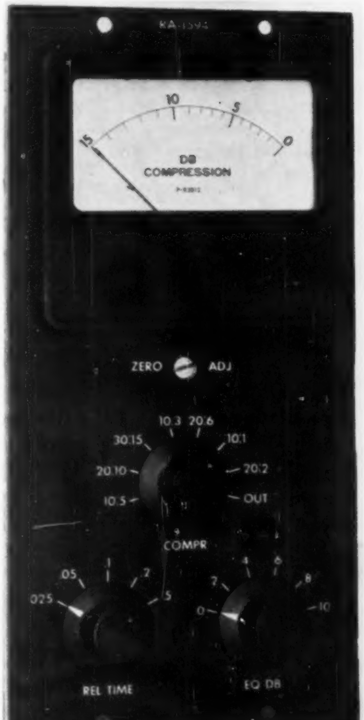
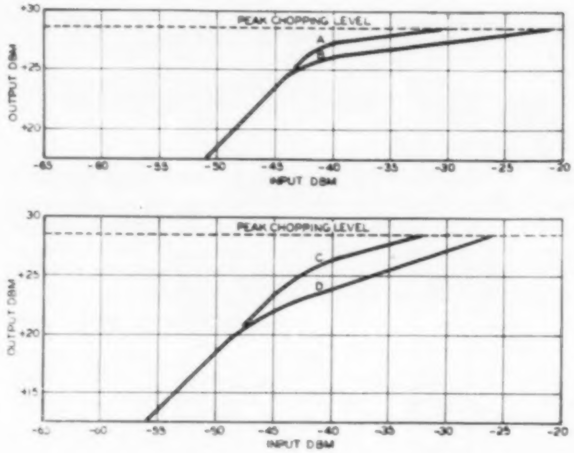


Fig. 3. The compressor-amplifier control unit.



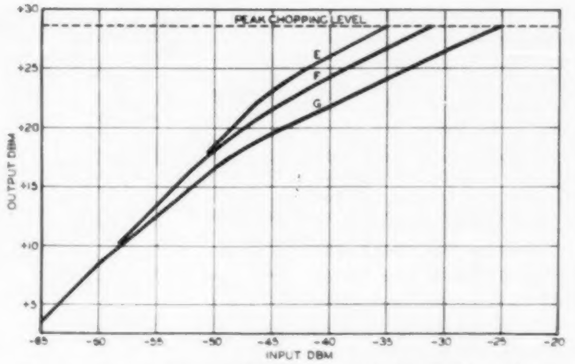


Fig. 4. Compressor amplifier characteristics: limiting characteristics (top left) are A 10 : 1, B 20 : 2; compression characteristics (lower left), C 10 : 3, D 20 : 6; and (above), E 10 : 5, F 20 : 10, G 30 : 15.

Fig. 5. The balance test oscillator.

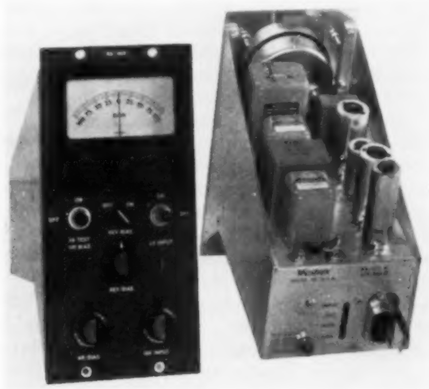


Fig. 6. Front and rear of noise-reduction unit.

Balance Test Oscillator

A new test oscillator was developed to provide a suitable means of balancing out the transients introduced by the compressor action, and this highly portable unit is shown in Fig. 5.

Compression amplifiers have been balanced in the past by the deliberate introduction of an in-phase d-c transient on the grids of the push-pull variable-gain tubes or by the introduction at the same points of a 60-cycle signal. Balance controls have then been adjusted for minimum output. Neither of these methods has resulted in a completely satisfactory balance for program material. The new oscillator utilizes a different approach which has proved to be most satisfactory. Credit must be given to the engineering staff of Goldwyn Studios for suggestions concerning a suitable type of signal and for cooperation in tests of the prototype units.

In the new transistorized oscillator the output consists of a train of pulses of 20 kc, and the duration of each train and interval between trains is 1 sec. The 20-kc frequency was selected as being suitable for the following reasons: firstly, it provides an adequately steep wave front; secondly, it is within the frequency response characteristic of the amplifier; and finally, it is outside the audible frequency range and readily separable from the low-frequency component.

The pulse duration of 1 sec on and 1 sec off was selected because this is sufficiently long to allow amplifier adjustments to be made while observing a volume-indicator meter connected to the output of the amplifier, but not so short that the amplifier does not recover even with the longest release time.

The unit is supplied with power from an internal mercury cell switched on by the introduction of the associated plug and test cord and the current drain is so small that it may be expected to operate for a year or so without replacement.

Exposure Meter Circuit

A new approach has been used, and considerable simplification of the exposure-meter circuitry effected by the use of a cadmium-sulfide photoconductive cell as the exposure cell in the recorder. The sensitivity is such that it may be connected directly to the exposure meter. A source of direct current at 40 v is connected in series, and the sensitivity control is merely a rheostat connected in shunt across the meter.

The exposure meter is used for measuring relative exposure and setting noise-reduction current in the case of variable-density systems; and in the case of variable-area systems, the circuit is used in conjunction with the record-reference lamp circuitry in order to determine the required value of record-lamp current to give the correct exposure. By the operation of a knob in the recorder to either of two positions, the light from either the recording or an identical reference lamp is made to fall on the photoconductive cell. After initial determination of the correct value of recording-lamp current in the usual manner, the value of relative exposure is noted and maintained at this figure for all future recordings by changing the lamp current as required.

As the reference lamp is in operation for only short periods of time, it does not age as rapidly as the recording lamp. A fixed value of reference-lamp current may be used, therefore, and the light from this lamp used as a source of calibration for the exposure meter.

Noise Reduction Unit

Figure 6 shows the front and rear of the noise-reduction unit. The audio input is of high impedance and is intended to be bridged across the 600-ohm light valve circuit ahead of the light-valve equalizer, while the d-c output is designed to work into a light-valve circuit of approximately 0.5-ohm impedance. A minimum level of about +3 dbm is required for full bias cancellation, and the frequency characteristic is such that essentially the same input level is required to cancel completely the bias current for any frequency from 50 to 12,000 cycles.

The maximum available forward bias current is 800 ma and the maximum available reverse bias, as required for certain density recording applications,

Fig. 7. The recorder.

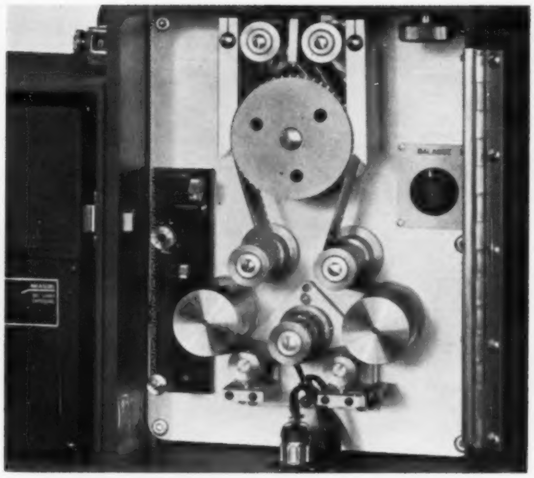


Fig. 8. The film compartment.

is 500 ma. Facilities are provided for reversal of the forward bias in order to obtain full track exposure for density measurements in variable-area recording.

The input switch on the unit gives the dual function of connection or disconnection of the input signal to the remainder of the circuit, and at the same time enables or disables the light-valve path. This reduces the number of switching operations, and provides protection against operation of switches in the incorrect sequence which might result in damage to the light valve. Four ranges of bias current metering are provided and the meter connections are taken to the output connector, making it available for use for measuring magnetic bias current when the system is employed for magnetic recording.

Power Supplies

Identical line-regulated power units of the saturable-reactor type are provided for both the vacuum-tube heaters and the record-lamp power. Each unit is capable of delivering up to 8.0 amp at either 12 or 13.5-v d-c with a ripple of less than 1% and the supply voltage may be either a nominal 115 v or a nominal 230 v at a frequency of either 50 or 60 cycles. Regulation is such that the output does not change more than 0.5% with line voltage changes of $\pm 13\%$, and not more than 5% with a change in load over the range of 25 to 100%.

It is interesting to note that it is unnecessary to provide external protection circuits on either the input or the output with this type of unit since protection is afforded by magnetic saturation against short circuit and short duration overload.

The 275-v supply unit is a general-purpose unit designed to furnish plate voltage for low-noise-level equipment requiring a well-regulated supply. It is intended to operate from a nominal 115-v, 50- or 60-cycle supply and delivers an output of up to 200 ma at a nominal 275 v with less than 3 mv of ripple. Control is provided of the output voltage over the range of approximately 265 to 300 v.

Regulation is such that the output voltage does not vary more than 1 v with line variations of ± 10 v and load variations from 0 to 200 ma.

Recorder

General

Four versions of the recorder are available to meet the studio requirements. The basic recorder dimensions and design are the same in all cases. Variable-area recording on either 35mm or 16mm film is accommodated by installing a variable-area modulator. Variable-density recording is accommodated similarly by installing a variable-density modulator. These modulators may be mounted interchangeably without requiring additional machine work. Operation with either 35mm or 16mm film is provided by the use of appropriate components in the film path and in the drive mechanism.

Figure 7 shows the front of a recorder equipped with a variable-area modulator for operation with 35mm film. The film path is symmetrical and permits film travel in either direction. The film is operated in the forward direction to record variable-area negative soundtrack and in the reverse direction to record variable-area direct-positive soundtrack. This latter type of recording with the light valve has been described previously.[1]

Figure 8 is a close-up view of the film compartment and in this case additional facilities provide for magnetic recording. The film path contains a large sprocket, two filter rollers, two impedance drums and two idler rollers which guide the film between the magazine and its two contacts with the film sprocket. With this path, film threading is relatively simple. The correct length of film loop is indicated by a signal lamp which lights if the film loop is in error by one or more sprocket holes in either direction. The facilities for magnetic recording add an assembly containing an idler roller and two magnetic heads, located midway between the two impedance drums which are ideal translation points. For magnetic recording the film path is under the idler roller which brings the magnetic film in contact with the record and monitor magnetic heads. For photographic recording the translation point is at the lefthand impedance drum and the film path is over the idler roller which lifts the photographic film clear of the magnetic heads.

The mechanical filter which is located in the film loop is quite effective, and with the equipment in proper operating condition the total flutter at either the optical or magnetic translation point does not exceed $\pm 0.08\%$ rms with 35mm film. With 16mm film the amount of flutter may be slightly higher, dependent to some extent upon the film stock, the accuracy of the sprocket hole punchings, etc.

One feature which has contributed materially in maintaining low values of flutter over long periods of time is the use of a different combination of materials to provide the friction in the takeup. A felt disk is used to drive a polished glass disk. The felt may be operated dry or, which is slightly preferable, with a light grade of oil lubricant. The torque develops at a cold start and after three hours of continuous operation for a given take-up condition varies less than 3% and remains within this range over long periods of time, insuring consistent and trouble-free operation.

A choice of four types of motor operation is provided for the recorder. These are single-phase and three-phase synchronous operation, distributor inter-

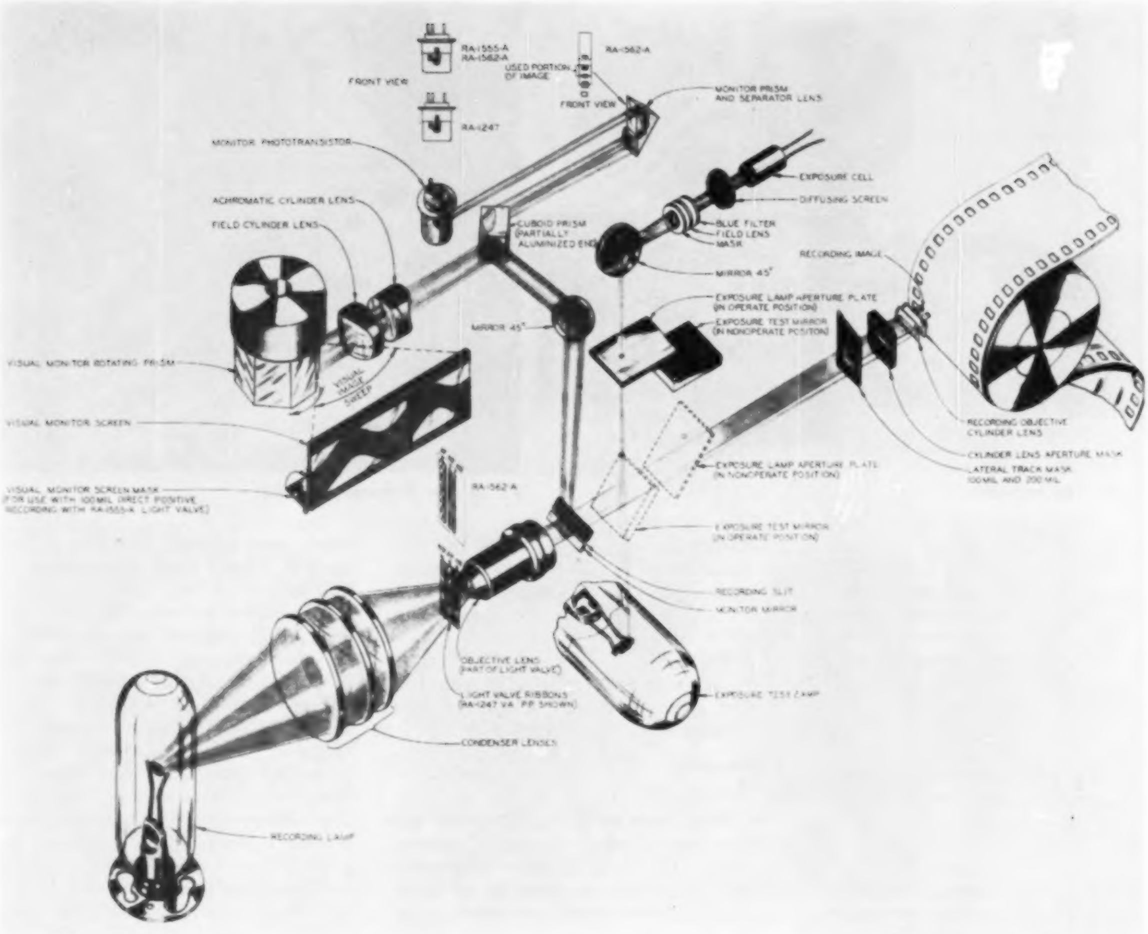


Fig. 9. Schematic visualization of the optical system.

lock from start with the usual interlock motor, or a composite motor which provides interlock from start either from a distributor or from other composite-type motors in the system with the alternate choice of three-phase synchronous operation. In any of these cases the film may be operated either in the forward or in the reverse direction.

The drive from the motor is through a timing belt to a cross-shaft and through a pair of right-angle helical gears to the film-sprocket shaft. A V-belt from this latter shaft goes to a take-up assembly mounted on top of the film compartment housing. A round belt from the take-up assembly goes to either of two belt pulleys on the magazine depending on the direction of film drive.

The control panel located below the modulator compartment contains a motor switch, a switch for controlling the direction of rotation of the motor, an indicator lamp to show the motor operating situation and a lamp which indicates that the film loop is correctly set. An additional three-position switch is provided when composite motor operation is installed. It sets the appropriate connections for motor operation from a distributor bus, for interlock operation with similar motors or for independent synchronous operation. The electrical connections to the recorder are brought in normally to terminal strips. If plug connections are desired, optional plug-panel assemblies are available.

Modulators

The recorder, equipped with a variable-area modulator and with the appropriate light valve installed, will produce a negative or direct-positive, double-width, push-pull or standard soundtrack on 35mm film, or a negative or direct-positive standard soundtrack on 16mm film. The light valves, irrespective of type, may be removed and replaced or interchanged readily without affecting the position of the soundtrack on the film. A three-position switch selects the appropriate circuit connections for any type of light valve intended for use in the recorder.

The variable-area modulator contains three optical paths which will be referred to as recording path, optical and visual-monitor path and exposure meter path. Figure 9 is a schematic visualization of the complete optical system. The recording optical path is the same in principle, though somewhat improved in details compared with that previously described.[2,3] One interesting feature in this path is an indexed azimuth adjustment control which is sufficiently accurate to permit correction of a known azimuth deviation without requiring verification of the recording with a toolmaker's microscope.

The two monitor optical paths employ features which are novel and merit consideration in some detail. Both paths start at the recording slit one edge of which is formed by a front-surfaced mirror. This mirror reflects the lower part of the optical beam, which is not used for recording, upward onto a 45° mirror which reflects the beam onto a cuboid prism, a part of whose front surface is aluminized. The aluminized surface reflects a part of the beam through a field-lens assembly and onto

the rotating eight-sided reflecting prism. The rotating prism reflects the beam onto the visual monitor screen and at the same time provides a horizontal sweep. The result is a repetitive sweep of an enlarged image of the light-valve ribbons, which produces on the monitor screen a variable-area pattern similar to that which is recorded on the film. For purposes of adjustment the test oscillator supplied in the transmission cabinet supplies a frequency which is adjusted to provide a standing wave pattern on the screen.

The optical-monitor path starts with the light that passes through the unmirrored portion of the cuboid prism. This light is deflected to the monitor prism and separator lens. The monitor prism is at an image plane and this permits applying appropriate masking at this point. The monitor prism directs the beam of light onto the monitor photo-transistor. The separator lens provides an essentially variable-intensity beam of light at this position which is an essential requirement because of the extremely small sensitive area on the phototransistor. Special associated circuitry was required to stabilize the output of the photo-transistor with temperature change, particularly during the early warm-up of the recorder.

The exposure-meter optical path provides means for comparing the light from the recording lamp which passes through the light valve with light from a reference lamp. By rotating a mirror and aperture assembly to either of two positions, the light from either source is made to fall on a photoconductive cell, the leads from which connect to the external exposure meter and associated controls located on the panel in the transmission cabinet. In Fig. 9 the mirror-aperture assembly is shown in the position which permits the light from the reference exposure test lamp to pass through the aperture, to be reflected by the 45° mirror, to pass through the mask, field-lens and blue-filter assembly and through the diffusing screen and onto the exposure cell. With the mirror-aperture assembly rotated to the alternate position, the main recording light which passes through the light valve is similarly reflected upward onto the 45° mirror and onto the exposure cell.

An improved technique has been employed in making the recording slit used in the recording optical path and this has resulted in an improved response at the high end of the frequency characteristic recorded on the film, both for 35mm and 16mm operation. The frequency characteristic, recorded on 35 mm film by the direct-positive method and maintaining constant modulation of the light-valve ribbons, shows 8000 cycles to be down a nominal 5 db with respect to 1000 cycles. The characteristic was obtained by reproducing the film through a system which had been corrected for reproducing losses by reference to the standard SMPTE Frequency Test Film.

The variable-density modulator is essentially similar to those previously used in variable-density recorders.[4]

Monitor Amplifiers

Figure 10 shows the optical-monitor amplifier and the magnetic-monitor amplifier both of which are plug-in units mounted in the base of the recorder. Both operate from a 75-v d-c source and require approximately 7 ma of current.

In the case of the optical-monitor amplifier the output from the phototransistor is connected directly into the base of the first common-emitter transistor stage and the emitter circuit of the second stage is extended through the plug connector to a remote gain control potentiometer.

The second stage is connected to the output transformer, and either 50- or 600-ohm output circuits are available.

The output level is approximately 0 dbm and the frequency characteristic is substantially flat from 50 to 10,000 cycles.

The magnetic-monitor amplifier is designed to receive an input from a low-impedance magnetic head and gives a nominal 0-dbm output at an impedance of either 50 or 600 ohms.

Four common-emitter transistor stages are employed and temperature stabilization is provided in the first two and second two stages.

The 6-db-per-octave slope for magnetic reproduction is obtained by a network in one of the feedback paths and low-frequency post-equalization is provided in a similar manner by another network in a second feedback path. This low-frequency post-equalization may be strapped for a flat overall response from film which has CinemaScope Westrex or no low-frequency pre-equalization.

The nominal output from a fully modulated, 200-mil track is 0 dbm and both 50- and 600-ohm outputs are provided.

Conclusion

The design of this installation appears to be very satisfactory in terms of performance, ease of operation and versatility of application. Many improvements have been made over existing systems and a number of novel features have been incorporated. It is believed that these innovations will be found useful and that the system should find wide application.

Fig. 10. Optical and magnetic-monitor amplifiers.

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Discussion

George Lewin (Army Pictorial Center): We have found when making long takes that if the current is constant the density will rise. After numerous tests, it appears that the only way to solve this problem is to ignore the lamp current and use instead a voltage measurement across the exposure lamp. Do you have such experience?

Mr. Brookes: We completely ignore the value of the lamp currents as read on the meter after the initial determination. Perhaps Mr. Crane will comment on the variation in exposure over a period of time while maintaining the same value of lamp current.

G. R. Crane (Westrex Corp.): The change in density during recording can, of course, result from any one of a number of factors. In our older systems, there has been occasionally a slight shift in the position of the incandescent lamp filament. As time goes on, the lamp heats up and, of course, the filament shifts slightly. Every effort has been made in this particular design to overcome this difficulty. The amount and size and optical arrangements for magnification of film image of the light valve has been so chosen that the position of the filament is not as critical as it has been in certain earlier systems and apparatus. I believe that this is closely related to the shift i. effective exposure as a function of time. The exposure meter we are employing here usually has a facility for checking exposure as seen by the film either before or after a take and not continuously during a take.

Mr. Lewin: Have you noticed that in order to keep the exposure meter reading constant it is necessary to drop the lamp current?

Mr. Crane: No we haven't. This has been a point of considerable gratification. We found the exposure meter fairly accurate in determination of effective exposure and, as I mentioned before, it is our belief that most of the errors or inconsistencies have been due to shift in lamp filament or position during the take, due to heating of the lamp or possibly other factors.

Mr. Lewin: Of course, I feel that the tests that we made were accurate enough to preclude any possibility of a drift in the lamp filament. We are thoroughly convinced that as the machine warms up, the ambient temperature gets higher. If you keep the same exposure lamp current there will be increasing density on the film, therefore the alternative is to keep dropping the current. We found that if the voltage is kept constant, it

automatically compensates for the rise in exposure, but there is quite a discrepancy between the lamp current and the lamp voltage as the machine runs for a full half hour.

Mr. Crane: A very good point and I think it's one that all the users of this equipment would do well to investigate further.

Mr. Lewin: I should point out that this is true only for variable-area recording where the sensitivity is much greater with respect to lamp current versus density than it is in the density-type recording.

De Witt F. Morris (Universal Recorders): Is this new system available in both 35-32 and 16? And is it possible to interchange 16 and 35-32, to record either 16mm or 35-32 with the same equipment?

Mr. Brookes: There is 35-32 equipment but not designed for interchangeable recording of 16mm; 16mm facilities are available in a separate model.

Television Control Room Human Engineering Problems

By EDWIN B. PORES

A study of human factors in equipment design has been conducted. This paper describes in detail the design of a technical director's operating console used to assemble and control a TV film coordinating studio. The application of anthropometrical data is discussed. Psychological as well as physical factors are considered.

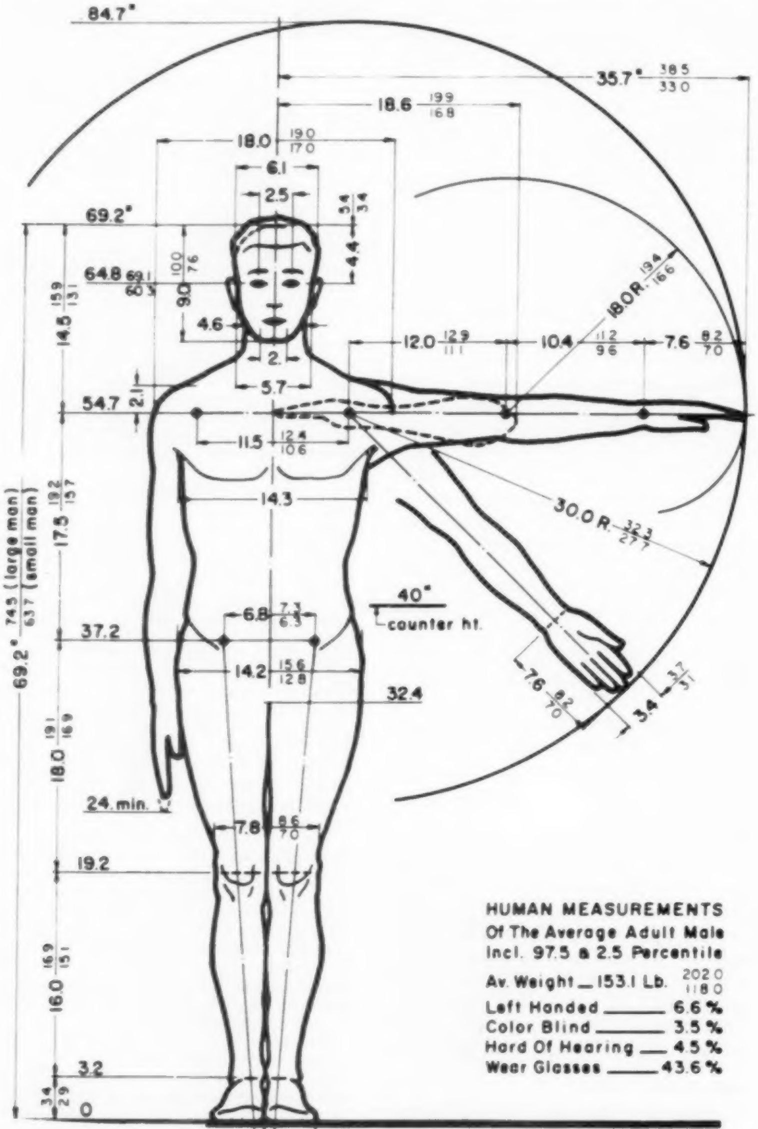

Fig. 1. Average anthropometric measurements of man standing. (Courtesy, Henry Dreyfuss)

In the commercial operation of network television broadcasting, certain human factors place a premium on "real" time. If, for example, a sponsor pays for a commercial broadcast by a local station during a station break from 8:29:20 P.M. E.S.T. to 8:29:30 P.M., the 10 sec can be worth \$4000. In the case of a network commercial sponsoring a "spectacular," as much as \$4000 a *second* may be involved. The network facilities engineer must, therefore, employ every available technique to protect not only life and limb, but he must also protect "real" time.

The design of the console and its control room environment, described in this paper, encompasses monochrome and color vision and high-quality audio monitoring. Facilities are provided for communication with a crew of technicians while switching video sources on a verbal or script cue, or on a prearranged time schedule.

Monochrome and Color Vision Problems and Their Solutions

Slight lines from the operator to the TV monitors, oscilloscopes and meters were considered first. Data from *Designing for People* by Henry Dreyfuss (Figs. 1, 2 and 3) were used. Also *The Anthropometry of Working Positions*, Wright Air Development Center Technical Report 54-520, contained a bibliography found useful as reference material.

Figures 2 and 3 show that when the operator is seated his eye level is approximately 50 in. National Broadcasting Co. has been using a 48 in. figure for sightline work with a fair degree of success.

Since color is perceived by the human eye with a narrower vertical limit than is the case with monochrome, the 70° limit of color discrimination could not be exceeded. Even in the monochrome control rooms we have attempted to minimize the need to move the head up and down to see monitors. Figure 4 shows an older master control center where the operator had to look up at the monitors. This room has monitors

A contribution submitted on March 20, 1958, by Edwin B. Pores, Facilities Engineering, National Broadcasting Co., RCA Bldg., Radio City, New York 20.

that cannot be seen by a short operator. Under certain complex conditions, the control position in the foreground, although designed for one operator, requires two men to operate it because of its panel length. In many respects, this master control violates good human engineering practice, but the newer facilities conform, as far as possible, to the highest standards of human engineering.

Control room lighting, as it affects the operators' vision and color acuity, was the second factor considered in the design of the console. The operators must be able to see the monitors, buttons, dials and oscilloscopes and also be able to read a script. The limiting factor was found to be the ambient light which, striking the face of the color TV picture tube, tended to reduce the range of reproduced luminance (40 ft-L on picture tube highlights). To solve this problem, every attempt was made to direct lights away from the monitors. The face of each monitor was coated with antireflection material and tests were made of shadow-free, coated metal screens.

Color temperature of the ambient light source was also considered, since a color TV receiver produces a white equivalent to Illuminant C (CIE and NBS standards). Fluorescent lights were used and we even trimmed filters to produce Illuminant C. The light level of the room is under the control of the operator by means of a variable-duty-cycle dimmer which maintains constant color temperature control to optimize the reading of scripts and viewing of monitors.

If ambient light precautions are not observed, color receivers at points remote from each other cannot show identical luminance, hue and saturation for identically colored objects even when adjusted for electronic similarity.

Console Design

In designing the console, previous designs were studied, operators were observed in action and interviews were conducted with operators and their supervisors.

In applying anthropometrical data, it was learned that the maximum average armspread is about 72 in., so the console panels were designed to a spread of about 50 in., to enable the operators to read and actuate all functions. The consoles have been built with a slight slope of 4° to 10°, depending on whether pushbuttons or knobs are to be turned (Fig. 5). This was done to reduce fatigue by giving a more natural approach to elbows, arms, wrists and fingers.

One other consideration was the proper balance of operating functions between the right and the left hand of the operator.

Pushbuttons were selected with the following considerations in mind: (1) length and throw of button, (2) force required to operate, (3) size and shape of button, and (4) feeling of accomplishment. This refers to the mechanical action of the switch which permits the operator to feel when contact is made without confirmation from the indicating tally light. A switch was selected which conformed to these requirements and also had the additional desirable feature of a built-in light. This saved space and helped in keeping arm movements minimized and sight lines optimal.

There are approximately 120 "hot-switch" buttons. (A "hot-switch" is an operation performed when the station is on the air and a failure of the function would be seen on all viewing screens.) These controls can be grouped into similar types of signals such as live cameras, film cameras, remote inputs, special effects, etc. To prevent operator error, the buttons were grouped spatially by function, the illuminated tally lights were color coded and metal divider bars were applied so that the operators can find the separation without looking for the buttons (Fig. 6).

In order to reduce tension on the personnel caused by "hot-switches," we developed a presetting system which enabled an operator to preset and automatically preview a camera, etc., before putting it on the air. If a mistake is made it can be more leisurely corrected since the operator knows it is not transmitted from his position.

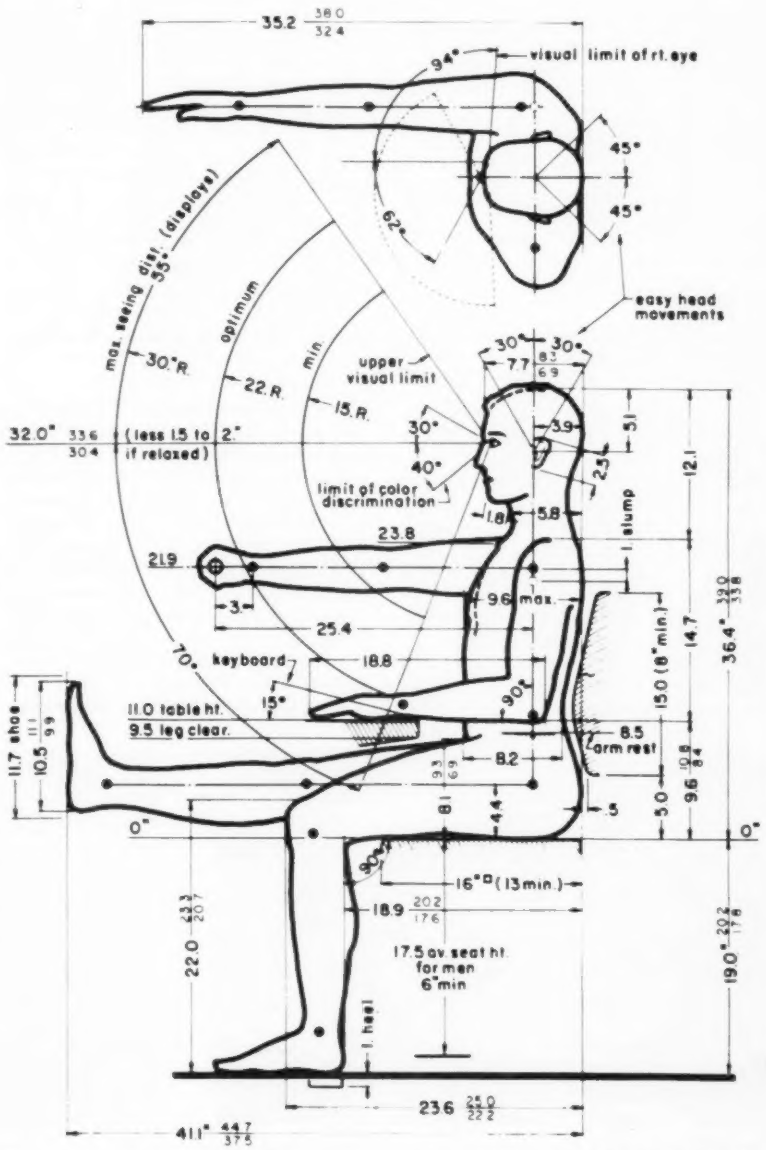

Fig. 2. Average anthropometric measurements, seated. (Courtesy, Henry Dreyfuss)

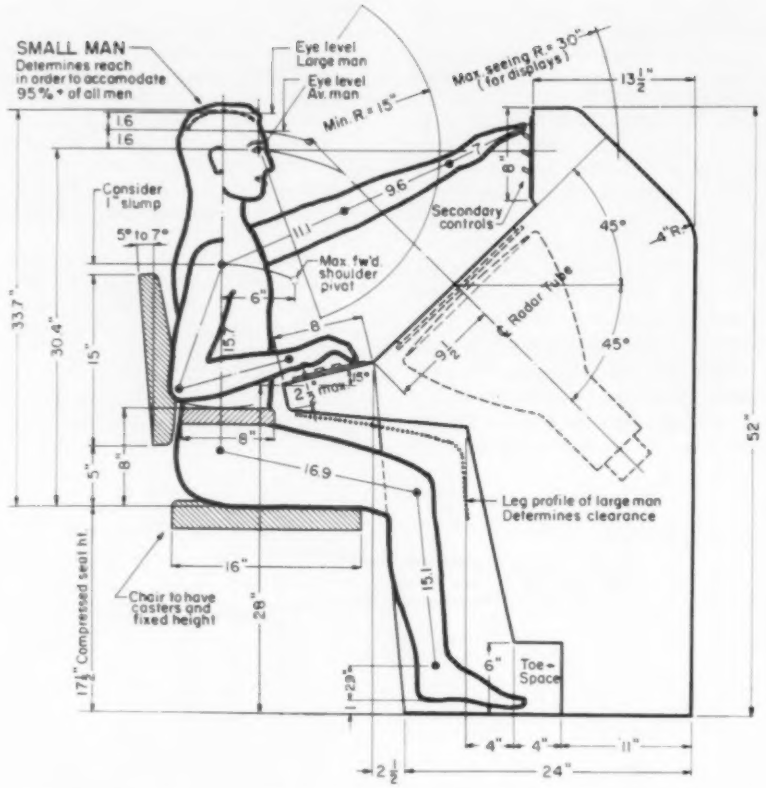

Fig. 3. Average anthropometric measurements of man seated at an electronic console. (Courtesy, Henry Dreyfuss)

In developing this plan it was observed that in order to put the preset function on the air, a single button marked "cut" was necessary to make an "air" switch. A study of the finger movements showed that the distance covered by the operator's finger as he reached for the button might vary from $\frac{1}{2}$ in. to to 18 in. The solution to this problem of waste motion was found to be the "cut bar," which was copied from the space bar of a typewriter (Figure 7). This control is now recessed to prevent erroneous operation.

Anthropometric and psychological factors were studied in determining the spatial relationship between the cut bar and the buttons. One requirement is that, when not in use, the operator's hand can span the bar without danger of accidental triggering. This requirement dictated size, force necessary to actuate and the "feel" of the operation.

Another relevant factor is that technical directors are usually nervous individuals and many of them tap their fingers prior to pushing buttons. For this reason, space has been allowed between the cut bar and the buttons. This area is called "nervous land," and it minimizes the chance of an accidental "nervous switch."

Functions of Technical Directors

In addition to viewing, switching and signal manipulations, technical directors have a "command" function. They must instruct cameramen, projectionists, audio operators, boom men, lighting electricians, etc., as part of a crew. This requires communications facilities called private lines, since in some cases the telephone company's private lines are rented for the longer cable runs.

A technical director in a live camera studio wears a combination headset microphone and receiver and in order to leave his hands free, foot switches are used so that he can contact film studios and master control. In earlier installations his voice was fed simultaneously to all persons. During the equipment setup and rehearsal period, utter confusion reigned, since many different operations were taking place. We now supply individual circuits which the technical director can select until air time; then he is in full control of all technical personnel.

The next small communications problem was the studio address system. This audio amplifying system enables the technical director or the program director to control technicians or actors (not connected by private line) within the studio during a rehearsal. An automatic interlock had to be provided so that when the studio is on the air, the system is disabled, otherwise the loudspeakers, blasting out instructions, would be broadcast.

The company has internal dial telephone systems for the engineering and program departments in addition to the conventional telephones.

In designing the console, it was necessary to allow for leg room and knee space (because of the depth of buttons and wiring) and still hang the tele-

Fig. 4. A large TV master control showing problem with sight line and arm lengths.

Fig. 5. Color TV studio control room, with excellent sight lines, studio address microphones, telephones and sloping panel.

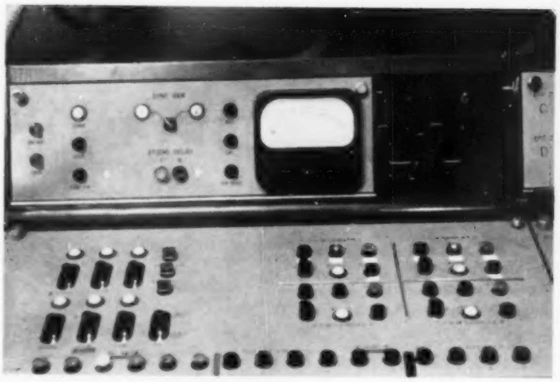

Fig. 6. Close-up of a color film control console showing oscilloscope, SOS keys, and tactile button dividers.

Fig. 7. Another view of color TV control room showing switcher buttons and cut bar.

phones. Panels were inset below the console to hang the instruments. Remote dial heads visible from the top were used. This minimized the problem of knocking phones off the hook and catching feet in the phone cords.

For the conventional desk set instrument we recessed the bases in wells built into the consoles. The production staff of program director, assistant program director, script girl, etc., must have access to these phones.

The source and level of sound signals accompanying the video program must be selected, controlled and monitored. A loudspeaker enclosure similar to the type shown on the ceiling of Fig. 4 is used in all control rooms. Identical decibel meters appear at the audio control position and in front of the technical director. The major human factor here was accessibility of the loudspeaker volume level and layout of the knobs shown on Fig. 5. The design of the audio control was another problem separate and distinct from the technical director's console, although it is a part of the overall control room.

A full-scale mock-up of the console was then built of wood and all operating panels were drawn up and pasted to the wood. The technical directors were then invited to sit before the mock-up to help us determine if the buttons and controls were arranged to their operating comfort and convenience. In this manner we were able to get their acceptance and cooperation. This approach made them feel that our design was not just an ivory-tower design, but rather that it best fitted the operating needs.

Miscellaneous Considerations

After observing the mock-up, the technical directors pointed out an interesting psychological problem. Some of them desired a wall or side panel between themselves and the program directors. This would serve to keep the program director (who is responsible for the artistic direction of the show) out of the "technical kitchen." This would have been very desirable for then we would have been able to design a wrap-around type of console and get a better panel layout. However, it would have reduced the "intimacy" of the two men working as a team and so, although it might have been a good technical solution, it was undesirable in terms of the overall system.

After seeing the mock-up, the operating group requested an oscilloscope on the console. Because of space limitations, some unique solution was required, so the arrangement shown in Figs. 6 and 7 was devised. The oscilloscope is mounted in the vertical plane, and a front surface mirror is set in the console hood so the technical director can see the scope. Access to the scope controls is generally for maintenance purposes and the operator seldom touches the controls. Some operators rely on this instrument, while others rarely look at the unit. The human engineer is constantly faced with human decisions and must assess cost vs. utility in his design.

On the upper lefthand corner of Fig. 6 a turnkey is marked "SOS" and another beneath it "EMG SW." By turning the SOS button, the technical director automatically rings an alarm and his microphone is connected to loudspeakers in the maintenance shop and master control. This control would be used only if trouble occurred when this studio was on the air, but it gives the operator a feeling of security to know that he can get prompt and automatic attention when he really needs it.

The "EMG SW" key automatically provides the technical director with an emergency switching system within the framework of his console. The emergency scheme reverts to our earliest type of unit which is a two-bus camera switcher. This system is very simple, and during the stress of an operating emergency, the psychological reversion to a pattern of earlier training has proven its worth.

Conclusion

We have attempted to achieve optimum human factor designs in all our operating control rooms in the hope of providing better technical support for our systems. We have standardization programs to bring consoles up to date, for nonstandard operation can be quite costly in errors.

Our present approach to design is, first, to analyze the total system problem and then proceed to the operating console, and the equipment associated with it. In other words, it is better to spend valuable engineering time determining first if the specific knob or even the whole console is necessary before solving human factor details.

We look forward to new techniques in automation and human engineering for greater reliability and safety in broadcast operations.

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Motion-Picture Laboratory Projection Facilities for Servicing TV Film Programs

By DON V. KLOEPFEL

Adequate viewing facilities are essential to quality control in a modern film laboratory. Facilities designed for viewing productions for the motion-picture screen must be increased and supplemented before they can be used to properly view and inspect film intended for TV presentation. This paper describes facilities provided by General Film Laboratories Corp. in Hollywood.

Viewing Rooms Equipment

Projection facilities provided by General Film Laboratories are designed to combine the essentials of quality control with additional equipment and services for the convenience of the customer. All viewing room auditoriums are air-conditioned, carpeted, draped and tastefully decorated. Comfortable lounge type chairs, upholstered theater seats and control consoles are provided.

Projection Room One (Fig. 1), provides exceptional facilities for customer service and quality control. Modern 35mm projectors, arc lamps and sound equipment with dual film attachments are basic equipment, as in any modern review room used for theatrical film production. Apertures and lenses for anamorphic projection, and all other aspect ratio and screen sizes satisfy requirements for trade or press screenings.

Supplemental equipment for servicing TV film programs includes special apertures. These apertures are 0.746 in. wide by 0.531 in. high, masking the area of the picture shown on the screen to that which will be visible within the mask of a television receiver. These dimensions are now recommended by the Association of Cinema Laboratories.[1] The corners are rounded to a radius of $\frac{5}{32}$ in.

Two separate soundtrack reproducers and an electrical interlock system are provided. With this facility a TV commercial, for instance, might be projected for editing purposes with a written message overlay and in synchronism with as many as four separate optical or magnetic soundtracks. This is a valuable service not only for editing, but for predubbing or prescoring operations as well. A mixing panel is provided in the auditorium console for controlling the level of the various sound reproducers. Also mounted on the control console is a sound volume control, a projection room intercommunication set, a telephone, work-light dimmers and controls to operate an all-electronic footage or scene counter.[2]

Screen readings are taken several times daily with a spot brightness meter[3] and screen brightness rigidly maintained to Academy standards. A variable diaphragm combined with a field-flattening lens is adjusted to keep screen brightness at the same level regardless of picture size or aspect ratio. When changing from one aspect ratio or screen size to another, the projectionist needs only to reset the diaphragm to a previously calibrated setting. No carbon changes or voltage adjustments are required, nor is it necessary to insert screens or filters in the light beam to maintain standard screen brightness.

A single-arc-type, high-speed projector is stationed at a third projection port in this room. Operating at 235 ft/min, it is useful for high-speed inspection of stock, work prints, etc. This projector is mounted on casters and can be replaced by a 16mm arc projector, also on casters, if the occasion demands. All connections to power and controls are the plug-in type.

The auditorium seats 50 persons, with additional seating for 25 on portable chairs. Two TV receivers are provided for closed-circuit presentation.

Importance of High-Quality 16mm Projection

A substantial amount of television presentation is through the medium of 16mm film. It is important then, to provide high-quality sound projection equipment for inspection purposes and for viewing first trials with the customer.

The projection equipment used in

Presented on April 23, 1958, at the Society's Convention in Los Angeles by Don V. Kloepfel, General Film Laboratories Corp., 1546 North Argyle Ave., Hollywood 28.
(This paper was received on March 17, 1958.)

Fig. 1. Projection Room One. A 17-in. monitor for 16mm closed-circuit presentation is placed at the left of the screen. A 21-inch receiver for 35mm presentation is at the center and a General Film Laboratories electronic footage and scene counter is at the right.

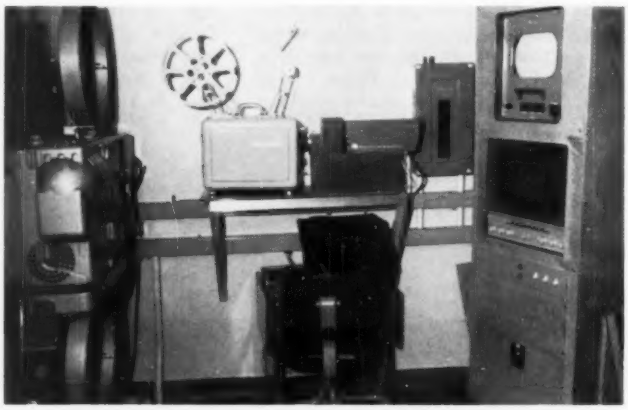

Fig. 2. Closed-circuit section with 35mm projector and camera (left), 16mm projector and camera (center) and mobile control cabinet with monitors and power supplies (right).

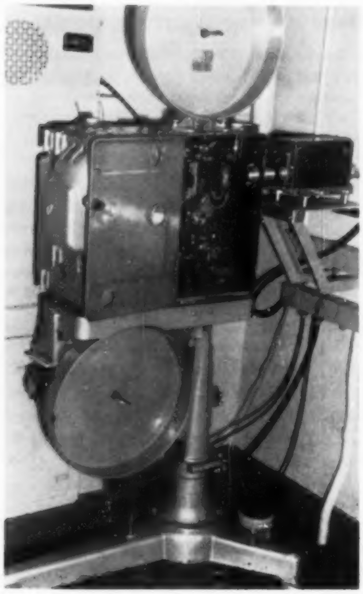

Fig. 3. 35mm projector used in closed-circuit section.

Room Two for this purpose is an Eastman Model 25 incandescent sound projector. The viewing room seats 10 people, and projection is on a solid specular theater screen. Draw drapes are opened to expose a large screen area for anamorphic projection. Screen brightness is controlled with a variable autotransformer. A 17-in. TV receiver is provided for 16mm closed-circuit presentation. Arc 16mm projection in Theater One with sound through the theater sound system is available when more seating capacity, or a larger screen, is needed.

Additional Facilities

Room Three is identical in size and basic equipment to Room One, and is maintained at the same levels and standards. First trials and dailies with separate soundtracks are projected here. This room is equipped with four-track magnetic sound penthouses and dual film attachments for single-track optical or magnetic soundtracks. As in Room One, a high-speed arc viewing projector is stationed at a third port.

Room Four, primarily a laboratory inspection room, is equipped with 35mm projectors and arc lamps. Using short focal length lenses, a large picture is produced on a solid specular screen for close observation of marginal defects in prints or fine grains. Standard theater sound equipment is used and the projectors are equipped with dual motors. When used as a release inspection room, the projectors are started at normal speed and sound synchronism is checked. Then the projectors are switched to the high-speed motors and operated at one and one-half times normal sound speed, or about 135 ft/min. An Eastman Model 25-B 16mm projector, mounted on casters, is rolled into an indexing device between the 35mm machines for 16mm projection. When in position the screen results are identical with those in Room Two.

Closed-circuit Television Film Presentation

The demand for motion-picture films for television will continue to increase. New projection facilities and techniques are necessary for the proper evaluation of such films in a laboratory. For this purpose two separate closed-circuit film video chains were installed (Fig. 2).

A 35mm projector with the familiar two-three, two-three pulldown movement is used to project a picture into a vidicon camera (Fig. 3). Changes made in the projector include the installation of a torque-type motor take-up, a ground pyrex filter in the light beam to eliminate lamp filament streaks, and a variable autotransformer used to control light intensity. The camera is mounted to the wall on an adjustable platform and is equipped with an Eastman 70mm 2.15:1 printing lens. The lens mount is motor-driven for mechanical focus. The camera output is fed to the master control and monitor unit (upper unit in Fig. 4) which also provides the camera voltages and contains camera target, beam and electronic focus controls. A phase control was added to the monitor unit so that negative images could be viewed in positive form. The output of the master control is tuned to a vacant channel and fed to the antenna connections of a standard 21-in. TV receiver. When the tuner is moved to channel 6, a coaxial relay switches the antenna input from the outdoor antenna to the output of the master control unit. The audio section of the receiver is also switched to receive the output of the projector audio preamplifier. This type of switching makes it possible to compare telecast material on other channels with the material being presented on the closed circuit.

The 16mm video chain is similar to the 35mm chain, except that the receivers are monitors rather than standard receivers with tunable front ends. Both master control units together with power supplies and video and audio controls are mounted in one cabinet. The cabinet is on casters so that it may be made accessible for service. Video section access panels are equipped with safety interlocks.

Film Laboratory Inspection Projectors

A battery of projection machines especially designed for high-speed viewing is used for 35mm television or screen daily or release print inspection. These machines have intermittent movements with double cam pins, 32-tooth feed and take-up sprockets and special film gates. They operate at 180 ft/min. The light source is a preheated incandescent lamp,

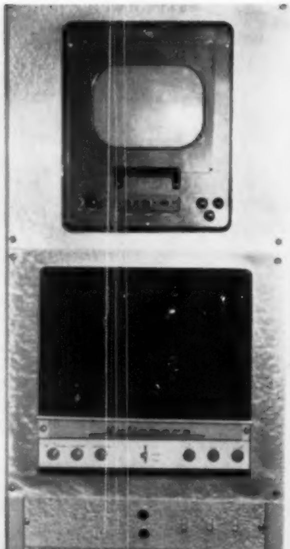

Fig. 4. Cabinet containing monitors and power supplies.

and screen brightness is maintained at Academy standards by reading the screen with a spot brightness meter and adjusting the voltage with autotransformers if necessary. Motor and lamp switches are interlocked for safety.

Projectors of the same general design are used in the inspection of 35/32 film. These projectors use double 16mm sprockets and project two paths of 16mm film printed on 35/32 stock. The speed is 80 ft/min, which is more than twice the normal 16mm sound speed. Viewing both paths, two half-hour TV shows can be checked for visual defects in about thirteen minutes.

For 16mm TV or screen release print inspection, 16mm sound projectors are used in a stacked arrangement, permitting comparison viewing.

A standard projector with a four-track penthouse magnetic reproducer and an optical soundhead for sound-checking release prints, and a standard silent projector designed for forward and reverse operation complete the projection facilities.

Conclusion

The following services are provided:

(1) Projection of 35mm or 16mm television or screen prints.

(2) Closed-circuit presentation of 35mm or 16mm TV commercials, pilots or completed shows.

(3) Trade or press showings at any aspect ratio for theatrical pictures.

(4) Editorial or cutting runs with silent picture, or with separate optical or magnetic track.

(5) High-speed inspection of stock or cut picture.

(6) Editing, prescoring or predubbing runs with as many as four separate optical or magnetic tracks.

(7) 16mm trade or press showings.

As time goes on it may be expected that increased production will bring about demands for larger and improved facilities. At present, however, these facilities meet requirements and conform to the highest standards of quality control and service.

References

1. "Laboratory practices on films for television," Recommended by Assn. of Cinema Laboratories, *Jour. SMPTE, 67:* 6–7, Jan. 1958.
2. Don V. Kloepfel, "An all-electronic counter for projection and other film uses," *Jour. SMPTE, 66:* 417–418, July 1957.
3. Frank F. Crandell and Karl Freund, "A new photoelectric brightness spot meter," *Jour. SMPTE, 61:* 215–222, Aug. 1953.

Discussion

Vaughn Shaner (Eastman Kodak Co): Would you comment on the aspect ratio of the monitor for viewing films for television projection?

Mr. Kloepfel: The size is 0.746 in. wide by 0.531 in. high. The corners are rounded to a $\frac{5}{32}$-in. radius.

Charles Buzzard (National Broadcasting Co., Hollywood): Is there a demand from advertising agencies to use your closed-circuit film facilities?

Mr. Kloepfel: Yes, we use them extensively, both 35 and 16. Problems include misplaced titles or titles too low or too high or something of that nature. Quite often the print may be perfectly all right so the agency is assured that the film is acceptable.

Printing Motion-Picture Films Immersed in a Liquid Part III: Evaluation of Liquids

By DONALD A. DELWICHE, JAMES D. CLIFFORD and WILLIAM R. WELLER

The elimination of the effect of negative support scratches by printing with the negative in intimate contact with a liquid requires a liquid with very specific properties. The criteria that influence the selection of a liquid are described. In the absence of a perfect liquid, the requirements of specific printing techniques must be analyzed in relation to possible compromise liquids or liquid mixtures. Over 90 compounds are evaluated by a system of "ratings" of their capabilities for use in printing. Decahydronaphthalene, trichloroethylene, tetrachloroethylene, and mixtures of Freon-113 liquid or methyl chloroform with tetrachloroethylene, or toluene are suggested as practical compromise liquids.

A PRINTING method has been described that gives high-quality motion-picture prints from badly scratched negatives through the use of a liquid having an index of refraction close to that of the negative.[1] The success of this method depends in part on the availability of a liquid having the proper physical and chemical properties. The criteria influencing the selection of a liquid are given below. For convenience, the printing method will hereafter be referred to as liquid printing.

Both contact and optical printing methods have been used successfully, and it is conceivable that liquid printing may be applied both to special salvage operations, such as making duplicate negatives from badly scratched originals, and to routine release printing. Printers may be designed to totally immerse the film, or films, in liquid while the printing exposure is made, or the liquid may be applied to the negative as a thin film by means of bead applicators or dip devices. All of these variations in the fundamental method of liquid printing will influence the choice of a suitable liquid.

A contribution submitted June 23, 1958, by Donald A. Delwiche, James D. Clifford and William R. Weller, Eastman Kodak Co., Color Technology Div., Kodak Park Works, Rochester 4, N.Y.

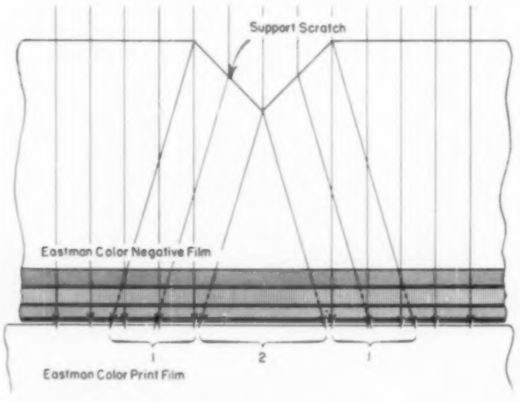

Fig. 1A. Cross section of film showing light rays being scattered by a scratch in the negative.

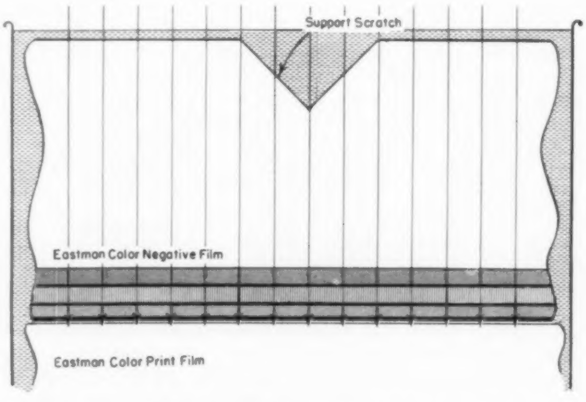

Fig. 1B. Cross section of same film surrounded by a liquid of proper index of refraction; the light rays are not scattered.

CONSIDERATIONS IN LIQUID SELECTION

Index of Refraction

Of first importance in the selection of a liquid is the index of refraction. Ideally, the refractive index of the liquid should be equal to the refractive index of the film support if the method is to be used for the elimination of the effects of support scratches. The refractive index of triacetate negative support is 1.478.

Figures 1A and 1B compare the mechanisms by which specularly illuminated support scratches are imaged on print film. The image recording plane is considered to be in perfect contact with the negative emulsion; thus, refraction effects occurring when refracted light rays from the scratch leave the negative and enter air need not be considered. This situation is present when near-perfect contact is obtained in contact printing, and when near-perfect focusing is obtained in optical printing. Specular light is considered since this condition produces the most serious scratch images.

From the diagram it is seen that the scratch image consists of several portions: first, there is an area (1) where both refracted light and normal unrefracted light are present, and hence a darker-than-normal image is recorded by the print in a negative-positive system; and second, an area (2) exists where little light is present to produce a lighter-than-normal image in the processed print. The same reasoning can be applied to a variety of scratches, and depending upon the geometry of the scratch, i.e. its width, depth, and angle of its walls with the film plane, images will be obtained with a great variety of characteristics. Because of the wide variations possible, such a study becomes extremely complex; however, it can be said that as the refractive index of the medium in contact with the film support approaches the index of the support, the scratch image becomes less objectionable. This consideration is important because it may not be possible to find a liquid with every desirable characteristic including an index which *exactly* matches the index of the support. The question arises: "How good must the match be to warrant the additional cost and problems of using a liquid?"

Initial development work indicated that scratch elimination was not satisfactory when the range of refractive index was considerably more or less than 0.10 from the index of the support. Several Dow Corning Silicone Fluids* were mixed in various proportions to provide samples ranging in refractive index from 1.40 to 1.53. (These mixtures are unsuitable for motion-picture printing because of their extremely low volatility and high viscosity, but they are suitable for use in a bench-type printing frame.) These liquids were used to make contact prints on Eastman Color Print Film, Type 5382, from an Eastman Color Negative Film, Type 5248, that had support scratches. An examination of these prints indicated that a difference in refractive index of 0.01 produced barely perceptible differences in the degree of scratch elimination. When the prints were projected, observers agreed that the scratches were objectionable when the liquids used were of an index below 1.46 and above 1.50. Thus, a practical range of ± 0.02 from the index of the support can be specified as the maximum tolerance range for effective elimination of the scratch image. Figures 2A through 2D show a few of the prints selected from the series. Figure 2E is a print made without liquid.

Fig. 2A. Printed with liquid, index of refraction 1.40.

Fig. 2B. Printed with liquid, index of refraction 1.45.

Emulsion Scratches

Elimination of the effects of scratches on the emulsion side of the negative must also be considered as a possible application of liquid printing. Obviously, deep scratches cannot be eliminated since they disturb or obliterate the image-bearing portion of the negative. In the case of color negatives, emulsion scratches that disturb one or more of the

*Dow Corning Corp., Midland, Mich.

Fig. 2C. Printed with liquid, index of refraction 1.48.

Fig. 2D. Printed with liquid, index of refraction 1.51.

dye layers will produce colored images. Light emulsion scratches, however, may only disturb the protective gelatin overcoating and, therefore, can be eliminated by the use of a liquid with an index of refraction equal or close to that of gelatin (1.52).

The thickness of the protective gelatin overcoating on color films is less than 2% of the thickness of the support. Since the effect of an emulsion scratch can be eliminated only if it is restricted to the depth of the protective gelatin layer, such scratches are of extremely small magnitude in relation to the possible size of support scratches. Laboratory measurements of typical base scratches indicate that these scratches can be, and often are, as deep as 25% of the total support thickness. In addition, motion-picture practice and machine design are such that the film is handled only on the support side, so the possibility of serious base scratches is increased. For these reasons it is desirable to use a liquid with a refractive index as close as possible to that of the support. Laboratory tests similar to the one described for the study of support scratches show that images of the most severe scratches in the gelatin overcoating are effectively eliminated by use of a liquid chosen to be optimum for elimination of support scratches.

Liquid Mixtures

A liquid with the proper index of refraction may be obtained from a mixture of two liquids, one of which has an index higher than the desired value and the other with an index below the desired value. The index of a mixture can be related to the volume per cent of its components in the mixture through the following approximation[2]:

$$P_1 = \frac{n_m - n_2}{n_1 - n_2}(100)$$

where:

P_1 = volume per cent of component 1,
n_1 = refractive index of component 1,
n_2 = refractive index of component 2,
n_m = refractive index of mixture.

This expression is a simplification and assumes volume additivity; therefore, small errors are possible if the two components of the mixture differ greatly in physical properties.

The above relationship is used in the following example to determine the proportions of methyl chloroform and tetrachloroethylene required to obtain an index of 1.478 at 20 C:

n_1, methyl chloroform = 1.438 at 20 C
n_2, tetrachloroethylene = 1.504 at 20 C

$$P_1, \text{ methyl chloroform} = \frac{1.478 - 1.504}{1.438 - 1.504} \times (100) = \frac{-.026}{-.066}(100) = 39.4\%$$

The same expression can be used in graphical form. Figure 3 shows the refractive indices of two mixtures: methyl chloroform-tetrachloroethylene, and Freon-113 liquid†-tetrachloroethylene.

The major reason for using a mixture rather than a single liquid is that the optimum index can be obtained through the use of two liquids that have desirable properties other than their refractive indices.

The disadvantages of a mixture are mainly associated with the problems of mixing and control. If the vapor pressure characteristics of the two components differ, the more volatile component will evaporate from the mixture faster than will the less volatile component. In the case of a methyl chloroform-tetrachloroethylene mixture, the methyl chloroform is more volatile and will evaporate at a higher rate than tetrachloroethylene. Thus, the percentage of methyl chloroform in the mixture gradually decreases and the index increases.

If two components have different densities, the index of a mixture can be determined by measurements of density with a hydrometer, once the relationship between density and refractive index for the combination has been determined.

†E. I. du Pont de Nemours & Co., Inc., "Kinetic" Chemicals Div., Wilmington 98, Del.

Temperature Effects

The effect of temperature on index must be considered. The index of most liquids decreases at the rate of about 0.0005 per degree centigrade as temperature increases. Since the refractive index can deviate as much as $\pm$ 0.01 from the optimum without loss of effectiveness for scratch elimination, the effect of temperature changes is generally insignificant.

Highly volatile liquids will cool the film by evaporation, and may reduce film temperature below the dew point. The chief problem here is not the refractive-index effects, but the danger of moisture condensation on the film. Care should be taken to insure that operations involving the use of a highly volatile liquid do not reduce the surface temperature of the film below the dew point of the air in the printing area.

Effect on Film, Printer and Process

Another critical requirement of a liquid is that it have no appreciable effect on the film. Obviously, water or aqueous solutions cannot be used because they wet the emulsion. Many liquids, such as acetone and ethyl acetate, are solvents for acetate film support and dyes. Other liquids, such as trichloroethylene, extract solvents and plasticizers from color films. Removal of plasticizers, for example, will result in undesirable changes in physical properties of the film support, such as increased curl and brittleness. Many liquids have no adverse effects upon short-term contact with film; however, they do extract components of the support and emulsion when in contact with film for extended periods. Printers designed to use such liquids should have adequate provisions for removal of the liquid from the film before winding. If there is any doubt as to the effectiveness of the liquid-removal technique, the negative should be thoroughly cleaned after use.

Contact printing places special restrictions on the liquid since the print raw stock and its process must also be considered. Many liquids are unsatisfactory because of undesirable effects on the sensitometric characteristics of print film. Other liquids, such as the alcohols, are unsuitable because of their tendency to remove or alter the antihalation backing on print film.

The effect of residual traces of the liquid on the print process must also be considered. Organic liquids that are immiscible with water may waterproof the print film and thus inhibit development if traces or droplets of the liquid remain on the film during processing. Other compounds, such as the metal organics, amines and amides may react with developer constituents and thus adversely affect the sensitometric characteristics of the process.

Fig. 2E. Printed without liquid.

Although a compound in *pure* form is known to have a low film effect, the *commercial* grade compound may have an appreciable film effect because of impurities or additives. Any liquid that is considered for use in liquid printing should be thoroughly tested for effects on film. Such tests should include both short- and long-term contact of negative film with the liquid; and if contact printing is planned, tests should include short- and long-term contact of both exposed and unexposed raw stock with the liquid, and contamination of the print process solutions with the liquid.

Some liquids have corrosive effects on metal parts of the printer or have solvent actions on plastic and rubber parts. Uninhibited trichloroethylene is a liquid that is corrosive to some metals, causing complications in printer design. Almost any volatile organic compound is a solvent for at least some plastic and rubber parts; therefore, contact of these materials with the liquid must be avoided. Solvent effects will cause eventual failure of the part and may result in coloration of the liquid or a shift in refractive index.

Liquid Removal

One of the important considerations in both printer design and liquid selection is the problem of removal of the liquid from the negative after printing. Contact liquid printing presents the additional problem of removal of liquid from the print film. Several techniques can be utilized:

1. Removal by Evaporation

The liquid may be removed by evaporation immediately after the film passes through the printer gate. Methyl chloroform, Freon-113 liquid, and trichloroethylene are sufficiently volatile to

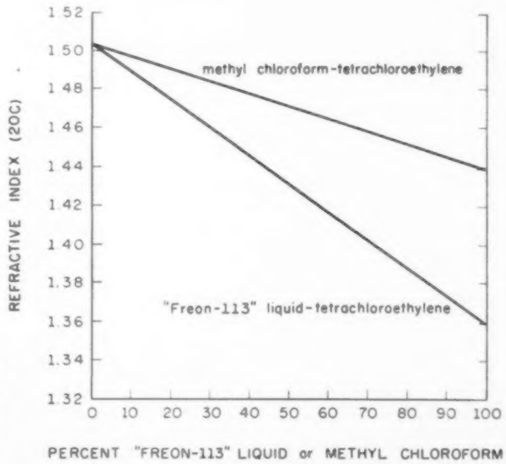

Fig. 3. Index of refraction plotted against per cent Freon-113 liquid or methyl chloroform with tetrachloroethylene.

evaporate completely when the film is allowed to travel over a fairly short distance through a drying chamber. If the liquid is inexpensive, the vapors can be exhausted from the area and expelled. Expensive liquids may warrant the use of vapor recovery equipment.

2. Removal by "Stripping"

The liquid may be stripped from the film by use of air knives or high-efficiency air squeegees.[8] If the liquid is fairly nonvolatile, most of the liquid can be recovered through the use of suitable shields and collectors around the squeegee. The recovered liquid can be pumped or allowed to run back into the liquid reservoir on the printer. Filtration is required to remove dirt. When air squeegees are used, some of the liquid will be vaporized even if the liquid is relatively low in volatility, and measures must be taken to exhaust or collect this vapor. Decahydronaphthalene (Decalin solvent‡) which is relatively low in volatility can be removed in this manner. In tests utilizing a pair of air squeegees in tandem, Decalin solvent was completely removed from film at speeds up to 100 ft/min. Warm air will improve the efficiency of this technique, but more liquid will then be vaporized and lost.

Whether a particular liquid can be removed by stripping depends in part on its viscosity, surface tension and volatility. Obviously, there is no firm dividing line between removal by evaporation and removal by stripping. Since air knives can be used effectively with a very volatile liquid and some of the liquid will be collected rather than vaporized, the techniques are variable in terms of the relative amount of the compound that is stripped and collected as liquid, and the amount of the liquid that is vaporized and exhausted.

In judging what technique is to be used, the volatility or evaporation rate of the liquid must be evaluated. Although boiling-point data give a general indication of how a liquid will perform, evaporation rate is affected by a large number of factors such as vapor pressure, molecular weight, surface tension, etc. Actual trial-and-error tests are the most practical means of determining the method of liquid removal.

Table I. Evaluations of Printing Liquids.

Refractive Index at 20 C		Effect on Film	Volatility	Flammability	Toxicity I: Respiratory	Toxicity II: Skin and Eyes	Cost I: $ per pound	Cost II: $ per 100 g
1.329	methyl alcohol	C	A	C	B	A	.50	
1.358	Freon-113 liquid	A	A	A	B	A	.64*	
1.359	acetone	C	A	C	A	A	.12	
1.388	*n*-heptane	B	A	C	A	A	.37	
1.388	*t*-butyl alcohol	C	A	C	B	A	.16	
1.395	1-fluoroctane	X	B	X	X	X		
1.399	*n*-butyl alcohol	C	B	C	B	A	.14	
1.406	*n*-nonane	X	B	C	B	B		
1.423	1,4-dioxane	C	A	C	B	B	.29	
1.435	Stoddard solvent	A	C	B	A	A		
1.438	methyl chloroform	B	A	A	B	A	.18*	
1.450	2,4-pentanedione	C	B	B	X	X		3.25
1.451	cyclohexanone	C	B	B	B	A	.32	
1.461	carbon tetrachloride	A	A	A	C	B	.12	
1.466	3-bromopropene	X	A	X	C	C		2.60
1.466	α-pinene	X	B	C	B	C	.14	
1.467	ethyl thioacetate	C	A	X	X	X		
1.468	1,4-cyclohexadiene	X	A	X	B	B		
1.468	1,3-dichloro-1-propene	X	A	C	X	X		
1.470	*o*-fluorotoluene	X	A	X	X	X		5.65
1.471	1,1,2-trichloroethane	X	A	A	C	A	.14	
1.472	1-α-fenchene	X	B	X	X	X		
1.473	dipentene	X	B	B	B	B	.15	
1.475	Decalin solvent	A	B	A	B	B	.50	
1.475	α-phellandrene	X	B	X	X	X		2.60
1.476	1,2-dihydrotoluene	X	A	X	X	X		
1.477	ethyl selenide	X	A	C	C	C		
1.478	trichloroethylene	C	A	A	B	B	.15	
1.478	2-bromo-1-chloropropane	X	A	B	X	X		.95
1.479	1-bromo-2-chloropropane	X	A	B	X	X		
1.482	terpinolene	X	B	B	X	X		
1.483	1-iodododecane	X	C	X	X	X		
1.483	1,1,1,2-tetrachloroethane	C	A	A	C	C	.16	
1.483	diamylbenzene	X	C	B	X	X		.43
1.485	α-terpinene	X	B	X	X	X		
1.485	furfuryl alcohol	C	B	B	B	B	.21	
1.487	1-methylpyrrole	X	A	C	X	X		
1.488	nonylbenzene	X	C	B	X	X		
1.489	1-bromo-2-chloroethane	C	A	A	X	X		.72
1.490	*sec*-butylbenzene	X	B	B	B	B	.07	
1.490	triisopropylbenzene	X	C	C	X	X		
1.490	*p*-cymene	X	B	B	B	B	.48	
1.490	*sec*-amylbenzene	X	C	C	B	B		.28
1.491	decylbenzene	X	C	B	X	X		
1.491	allyl sulfide	C	B	A	C	C		4.95
1.492	*n*-propylbenzene	X	B	C	B	B		8.90
1.493	1-iodohexane	X	B	X	X	X		6.45

3. Closed System — Optical Printing

With this technique, no attempt is made to remove the liquid from the film during printing, which is possible in optical printing if the liquid has no long-term effects on the negative. The feed, gate and take-up areas of the printer are enclosed to prevent loss of liquid, and the negative is wound wet after printing. If more than one print is desired, the negative can be rewound wet, or merely transferred to the feed side of the printer for tails-first printing (if the first print was made heads-first.) Precautions should be taken to protect operating personnel from fumes and skin contact of the liquids. After printing has been completed, the negative is cleaned either by use of a second solvent, by passing the film through an auxiliary air-squeegee cleaning device, or by rewinding the film slowly in an evacuated chamber. This technique could be used with a liquid of medium-to-low volatility, such as Decalin solvent, and has the advantage of making it unnecessary to place complex cleaning devices and drying systems on the printer proper. Precautions to protect personnel from toxic effects of the liquids still remain a necessity.

‡ E. I. du Pont de Nemours & Co., Inc.

Flammability and Toxicity

Since the removal of the printing liquid often results in the vaporization of considerable quantities of the liquid, the flammability and toxicity of the liquid *and its vapor* must be considered.

A printer using a flammable liquid, such as toluene, must be either totally enclosed or the vapors must be fully exhausted from the printer or printing area. Since some vapors form explosive mixtures with air when mixed in

Table I. Concluded.

Refractive Index at 20 C		Effect on Film	Volatility	Flammability	Toxicity I Respiratory	Toxicity II Skin and Eyes	Cost I $ per pound	Cost II $ per 100 g
1.494	1,1,2,2-tetrachloroethane	C	B	A	C	C		1.34
1.494	diisopropylbenzene	X	C	B	X	X		
1.495	1-chloro-3-fluorobenzene	X	B	X	X	X		10.45
1.495	*m*-propyltoluene	X	B	X	X	X		
1.495	*m*-cymene	X	B	X	B	B		
1.495	diethylbenzene	X	B	B	B	B	.17	
1.496	toluene	B	B	C	B	B	.08*	
1.496	ethylbenzene	X	B	C	B	B	.15	
1.496	*t*-butylbenzene	X	B	B	B	B		6.70
1.496	1-iodopentane	X	B	X	X	X		
1.496	*p*-xylene	X	B	C	B	B	.21	
1.496	1-iodo-2-methylpropane	X	A	X	X	X		3.15
1.496	1-iodo-2-methylbutane	X	B	X	X	X		
1.497	mesitylene	X	B	B	B	B		11.80
1.497	1,2,4-triethylbenzene	X	C	B	X	X		.58
1.498	3-bromofuran	X	A	X	X	X		
1.499	commercial xylene	X	B	C	B	B	.32	
1.500	*o*-cymene	X	B	X	B	B		
1.501	2-picoline	X	A	C	B	B		.51
1.501	1-chloro-2-fluorobenzene	X	B	X	X	X		6.70
1.501	benzene	C	A	C	C	B	.06	
1.504	tetrachloroethylene	B	A	A	B	B	.22	
1.504	phenyl acetate	C	C	B	X	X		2.65
1.504	pyrrole	X	B	B	B	B		
1.504	2-cyclohexyl cyclohexanol	X	B	B	X	X		2.60
1.504	pseudocumene	X	B	X	B	B		.20
1.504	pentachloroethane	X	B	A	X	X		
1.505	*n*-propyl iodide	C	A	X	X	B		2.70
1.506	*o*-xylene	B	B	C	B	B		.31
1.509	pyridine	X	A	C	B	B	.75	
1.513	1,1-dibromoethane	X	A	X	C	B		8.90
1.516	methyl benzoate	C	B	B	A	A	.60	
1.518	anisole	X	B	B	C	C		.92
1.519	2,3-dimethylthiophene	X	B	C	B	C		
1.520	*p*-chlorotoluene	X	B	X	X	X	.45	
1.520	tetramethyltin	C	A	C	C	C		
1.520	2-methylthiophene	X	A	C	B	C		
1.520	1,2-dibromopropane	X	B	A	X	X		.98
1.522	*m*-chlorotoluene	X	B	X	X	X		4.50
1.523	1,3-dibromopropane	X	B	A	X	X		1.32
1.524	*o*-chlorotoluene	X	B	X	X	X		1.75
1.525	chlorobenzene	C	B	C	B	B	.11	
1.526	thiophene	X	A	C	B	C		2.55
1.538	1,2-dibromoethane	X	B	A	C	C		
1.540	1,2,3,4-tetrahydronaphthalene	X	C	B	B	B	.31	
1.553	nitrobenzene	C	C	B	C	C	.12	

*Estimated commercial price for one-drum lots.

certain proportions, exhaustion systems must be designed to prevent possible ignition such as could result from a sparking electric motor. Two-component mixtures, such as toluene–Freon-113 liquid and toluene–methyl chloroform, are somewhat less flammable than pure toluene because the nonflammable component, the Freon-113 liquid or methyl chloroform, tends to raise the flash point of the toluene; however, this effect is small and the flammability hazard is still present. Complete precautions should be taken to obtain safe conditions.

The precautions described above for flammable liquids also apply to toxic liquids. Compounds that are generally considered to be nontoxic may have this reputation only because they have relatively low volatility and do not usually produce a very high vapor concentration. In liquid-printing operations, where these compounds may be vaporized in large quantities, the opportunity for inhalation of the vapor is greatly increased and the hazard may become serious. The only solution to the problem is adequate ventilation and complete exhaustion of the vapors.

Cost and Availability

These factors are difficult to evaluate without specific information as to the use and method of operation involved in a particular laboratory. Where liquid printing is used as a salvage technique, liquid cost may be of little importance. For the more general use of liquid-printing techniques, cost considerations will depend on how much of the liquid can be recovered and re-used. This is an important factor when considering the merits of using either of two available liquids, one of which is higher in cost but lower in volatility. The greater opportunity for recovery of a less volatile liquid may justify its use.

EVALUATION OF POSSIBLE PRINTING LIQUIDS

Several liquids have been mentioned in the previous discussion that have possibilities for use in liquid printing. Table I lists the pertinent characteristics of these and other liquids evaluated by a system of "ratings." This system is described below:

Effect on Film

A – no significant effects;
B – low (no short-term effects);
C – high (very significant effects);
X – not known.

Volatility

A – high volatility (boiling point below 130 C and vapor pressure at 30 C over 15 mm Hg);
B – medium volatility (boiling point between 130 and 200 C and vapor pressure at 30 C between 2 and 15 mm Hg);
C – low volatility (boiling point above 200 C and vapor pressure at 30 C below 2 mm Hg).

Flammability

A – non-flammable;
B – low flammability (open-cup flash point above 100 F);
C – high flammability (open-cup flash point below 100 F);
X – flammability characteristics not known.

Toxicity

Column I — Respiratory

A – little vapor hazard in open areas;
B – moderate hazard — prolonged or repeated exposures or short exposures to high concentrations may be harmful;
C – hazardous — short exposures to vapors are dangerous;
X – insufficient toxicity information to estimate a meaningful rating.

Column II — Skin and Eyes

A – irritation unlikely from intermittent contact;

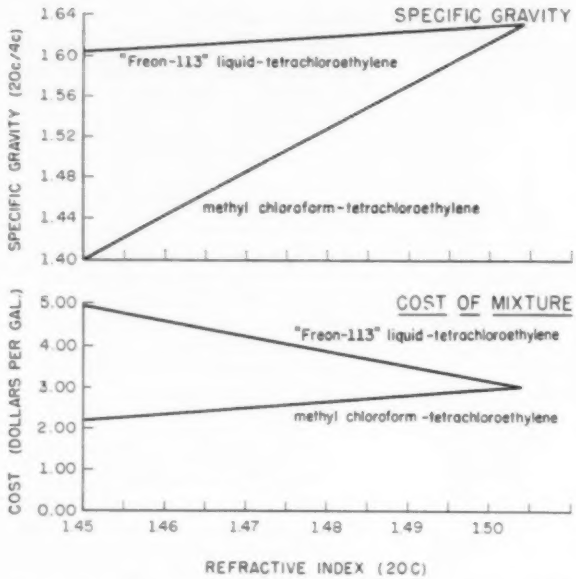

Fig. 4. Specific gravity and cost of Freon-113 liquid or methyl chloroform mixtures with tetrachloroethylene as a function of index of refraction.

B – possible irritation after prolonged or repeated contact;
C – hazardous — dangerous to use without adequate protection;
X – insufficient toxicity information to estimate a meaningful rating.

Cost and Availability

The costs per pound of industrial chemicals listed in the *Chemical and Engineering News Quarterly Report on Current Prices* (Third Quarter, 1957) are given in Column I. These prices are for commercial-grade chemicals in carload or drum lots and are not necessarily the prices the laboratory should expect to pay; however, they are generally indicative of the relative cost of the compounds.

In order to give a relative indication of the cost of compounds not listed in the above report, additional cost data, Column II, show the prices (List No. 40, October 1, 1956) for 100-g quantities of those compounds that can be purchased from the Eastman Organic Chemicals Dept., Distillation Products Industries, Rochester 3, N.Y.

System and Ratings

The rating system has been designed so that A represents a close approach to ideality, B indicates a generally undesirable quality that, with proper precautions, need not necessarily preclude the use of the liquid, and C signifies a serious deficiency that makes the liquid unsuitable for use in liquid printing.

Some liquids with unsuitable refractive indices are listed for their possible use in liquid mixtures or because they are illustrative of types of compounds that are unsuitable for liquid printing. Each characteristic of a potential liquid should be considered within the framework of a specific application. No single liquid is best for all printing systems.

Some of the liquids that have received a high overall rating and also have suitable indices are discussed in greater detail below. In addition, several liquid mixtures are discussed.

Decalin Solvent

Commercial Decalin solvent is a mixture of *cis-* and *trans*-decahydronaphthalene and generally is either all *trans* or a mixture of up to 60% *cis*. The refractive indices of the two isomers differ: the *cis* form has an index of 1.481 at 20 C, and the *trans* form has an index of 1.470. The index of a typical sample of commercial Decalin solvent was found by actual measurement to be 1.475, which is well within the limits determined as optimum for support-scratch elimination.

Decalin solvent has a very low effect on film, even after long-term immersion. It has no sensitometric effects on the Eastman Color Print Process, but is immiscible with water so that development will be inhibited under any residual droplets of the compound.

Its boiling point varies between 185 and 195 C, depending on the proportions of the two geometric isomers. Its vapor pressure is quite low at room temperature, and it can be classified as a liquid of moderately low volatility, so the stripping method of removal or use in a closed system is necessary.

The liquid is flammable, but has a much higher flash point (136 F, closed-cup) than liquids such as toluene, which are normally considered to be highly flammable.

Decalin solvent is reported to be relatively low in toxicity; however, it can cause dermatitis and possible systemic poisoning. The lack of reported cases of industrial injury due to this compound may be due in part to its low volatility. In liquid-printing applications where air squeegees are used for liquid removal, a much higher-than-normal concentration of vapor may result and adequate protection against breathing of these vapors should be provided.

Decalin solvent is a common industrial solvent and is commercially available. Its cost is about two times that of tetrachloroethylene, but its low volatility suggests recovery and re-usage.

Freon-113 Liquid

Freon-113 liquid has an index of refraction of 1.358, giving inadequate scratch-image elimination when used alone. However, its very low film effect, relatively low toxicity and nonflammability have made it attractive for use in mixtures.

Methyl Chloroform

Methyl chloroform, like Freon-113 liquid, is unsatisfactory for use singly in liquid printing because of its low refractive index (1.438); however, it has other properties that make it ideal as the low-index component of printing mixtures. Methyl chloroform has a relatively low film effect and is nonflammable. It is cheap and readily available. The relative merits of methyl chloroform and Freon-113 liquid are discussed in detail in a later section.

Tetrachloroethylene (perchloroethylene)

Tetrachloroethylene has an index of refraction of about 1.50 — close to the limit beyond which the index match is less than ideal. As discussed below, the refractive index can be adjusted to the optimum value by the use of methyl chloroform or Freon-113 liquid. Tetrachloroethylene has a relatively low film effect and has sufficient volatility for easy liquid removal. It is nonflammable but is moderately toxic, so adequate facilities for vapor removal must be provided. Tetrachloroethylene is commercially available and moderately priced. With the exception of its toxicity and borderline index of refraction, it is an ideal compound for liquid printing.

Methyl Chloroform or Freon-113 Liquid in Tetrachloroethylene

Freon-113 liquid or methyl chloroform can be mixed with tetrachloroethylene to obtain a mixture with an ideal index match. As previously described, specific gravity measurements of the mixture can be used to control the proportions of the two components, and thus, the refractive index. The relationships between re-

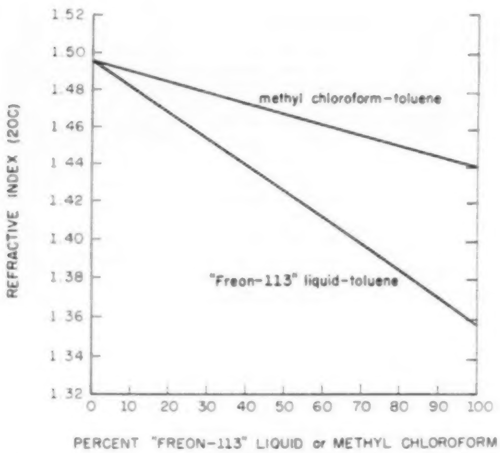

Fig. 5. Index of refraction plotted against per cent Freon-113 liquid or methyl chloroform with toluene.

fractive index and the volume per cent of Freon-113 liquid or of methyl chloroform in mixtures with tetrachloroethylene are shown in Fig. 3.

A higher concentration of methyl chloroform than Freon-113 liquid is required to obtain any given index, because the index of pure methyl chloroform is higher than that of Freon-113 liquid. Since the cost and specific gravity of the mixture are related to the concentration of the components which in turn affects the refractive index, it is more useful to consider the relation of these properties directly to refractive index (Fig. 4). As indicated by these curves, the addition of the cheaper methyl chloroform produces a mixture of lower total cost than the cost of pure tetrachloroethylene, whereas the addition of Freon-113 liquid raises the total cost of the mixture.

Because methyl chloroform is less volatile than Freon-113 liquid, a mixture using the former compound is less subject to change in refractive index due to evaporation.

A secondary advantage of a mixture using methyl chloroform can be seen by examination of the specific gravity curve. The greater rate of change of specific gravity with changes in refractive index indicates the superiority of the methyl chloroform-tetrachloroethylene mixture with respect to its ease of index control by the specific gravity technique.

Both mixtures are nonflammable and of about equal toxicity. Although Freon-113 liquid has a less serious film effect than methyl chloroform, film effects of mixtures containing either of these liquids in tetrachloroethylene are very slight for short contact times. When long-term contact is anticipated, as in release printing, it would be advantageous to choose the mixture containing Freon-113 liquid.

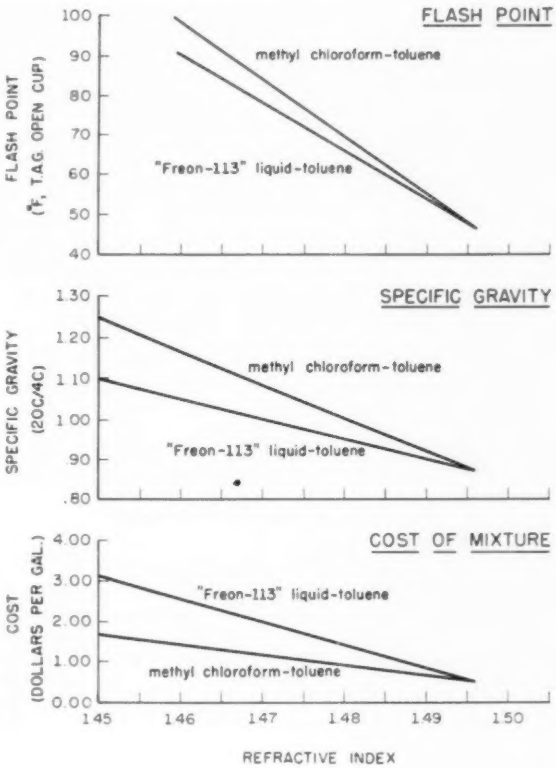

Fig. 6. Flash point, specific gravity and cost of mixtures of Freon-113 liquid or methyl chloroform with toluene related to refractive index.

Toluene

Toluene has an index of refraction of 1.495 — still within the range for satisfactory elimination of the scratch image; however, a more perfect index match may be obtained by the addition of a compound of lower index. Toluene has a moderate film effect (greater than tetrachloroethylene, but somewhat less than trichloroethylene). It is moderately toxic and flammable (closed-cup flash point, 40 F).

Freon-113 Liquid or Methyl Chloroform in Toluene

Freon-113 liquid or methyl chloroform can be mixed with toluene to give a mixture with an optimum refractive index. The addition of these volatile, nonflammable compounds also suppresses the flammability of toluene slightly.

Specific gravity measurements of the mixture can be used to control the proportions of the two components. The relationships between refractive index and the volume per cent of Freon-113 liquid or of methyl chloroform in mixtures with toluene are shown in Fig. 5. A higher concentration of methyl chloroform than Freon-113 liquid is required to obtain any given index. The flash point, cost, and specific gravity of the mixture are related directly to refractive index in Fig. 6.

Methyl chloroform has a greater long-term effect on film than does Freon-113 liquid; however, the same precautions must be taken with either mixture because of the long-term effect of toluene.

Trichloroethylene

Trichloroethylene has an index of refraction of 1.478 and thus is ideal for elimination of scratch images; however, the compound extracts solvents and plasticizers. Uninhibited trichloroethylene corrodes most of the stainless steels. It is highly volatile and practically nonflammable, but is moderately toxic. Trichloroethylene is commercially available and inexpensive. In view of its severe film effect, corrosiveness and toxicity, it is far from ideal for use in liquid printing.

SUMMARY

A large number of organic liquids were examined, but only a few seemed promising enough to investigate in detail. Because high volatility tended to alleviate the problem of liquid removal, the search for liquids was biased in this direction. Unfortunately, high volatility is often accompanied, singly or in combination, by high flammability, toxicity and undesirable solvent action. These disadvantages are found less frequently in liquids of lower volatility. Decahydronaphthalene is an example of a liquid of lower volatility. It is quite possible that further investigation of the medium-volatility category would yield

other liquids more satisfactory than decahydronaphthalene.

The use of liquid mixtures should be investigated further. A pair of compounds may be found that form a constant-evaporating mixture with a refractive index within the optimum range. This possibility would eliminate the differential-evaporation disadvantage of a mixture.

It has been the purpose of this paper to outline the criteria that should be considered when selecting a compound for use in liquid printing. This is not a complete report on all possible liquids, but rather a résumé of our investigation of some classes of liquids useful in liquid printing. The authors make no attempt to recommend a particular liquid to the motion-picture industry.

Acknowledgment

The authors wish to thank Dr. D. Fassett and Dr. R. Roudabush for their assistance in obtaining toxicity data on the various liquids described in the paper.

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2. J. R. Partington, *An Advanced Treatise on Physical Chemistry, Vol. IV*, Longmans, Green and Co., Ltd., London, 1953, p. 72.
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A Powered Film-Cleaning Drum

By HARRY BRUEGGEMANN

One of the most expensive methods of film-cleaning, that of cleaning by hand on a drum, is considered to be the best for achieving the cleanest possible film. In building the drum described in this paper every effort was made to make the operation as efficient as possible. The drum is motor-driven, forward and reverse, has a solenoid brake, and the drive and the brake can be disengaged for manual operation.

Dirt is always a problem. But amounts of dirt that are an annoyance to a housewife are catastrophic to a film laboratory. Dirt on negative shows up as white specks on the print; and even worse, if the dirt scratches the negative, the effect will be white streaks. When this is magnified 200 or 400 times in projection it is most displeasing to the observer.

The ideal condition of a complete absence of dirt cannot be attained; it can only be approached. The task of keeping film clean requires an attack from two directions — first, keeping dirt out of the areas where film is handled and second, removing it from the film when it does get on. The first is basically a job of housekeeping, and involves specialized janitorial services, a properly designed air-conditioning system, and techniques for minimizing the amount of dirt brought into the laboratory by personnel. The second requires equipment to remove dirt from film at various stages of handling in the laboratory. Experience has shown that some handling techniques are more apt to produce dirt on the film than others. For example, film shavings are almost certain to be found on negative after a splicing operation, while rewinding negative in a clean and properly humidified atmosphere will add very little dirt.

Presented on April 23, 1958, at the Society's Convention in Los Angeles by Harry Brueggemann, Pathé Laboratories, Inc., 6823 Santa Monica Blvd., Los Angeles 38.
(This paper, revised, was received on August 18, 1958.)

The amount of effort expended in keeping film clean must be apportioned among the various methods of cleanliness, at selected stages of the processing work flow, if the laboratory operations are to remain economical. Too little cleaning yields an unsalable product. Too much cleaning causes production delays, and the costs are far out of proportion to the results.

There are stages of laboratory production where the maximum effort must be put forth toward cleaning film. This maximum effort is, of course, correspondingly expensive and time consuming; therefore it is well worth while to search for the most inexpensive way to get the job done. Many methods have been investigated, including chemical and mechanical techniques, preventive programs and automatic and high-speed equipment.* The procedure which seems

* Two methods recently reported: (1) John W. Harper, "A high-speed velvet cleaner for color negative," *Jour. SMPTE, 66:* 17–18, Jan. 1957; (2) A. L. Ford, Jr., "An automatic rewinding and cleaning machine for motion-picture films," *ibid.*, pp. 19–21.

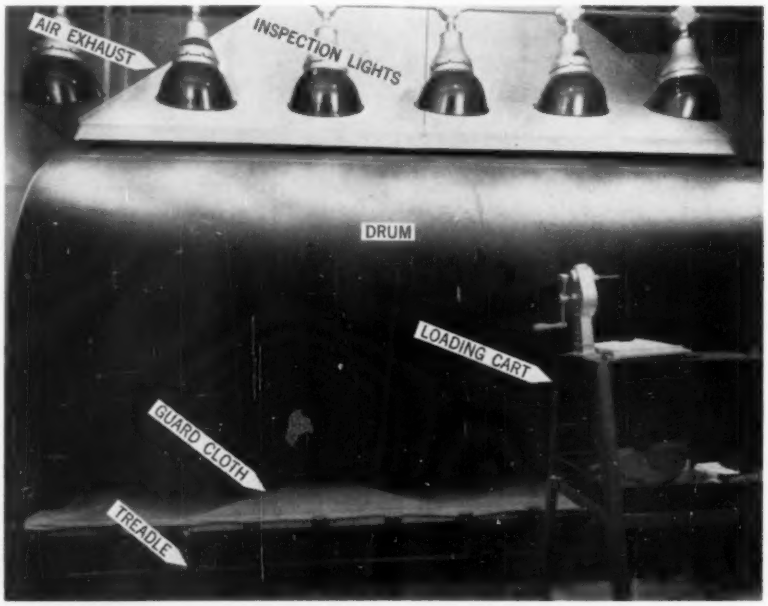

Fig. 1. The powered film-cleaning drum.

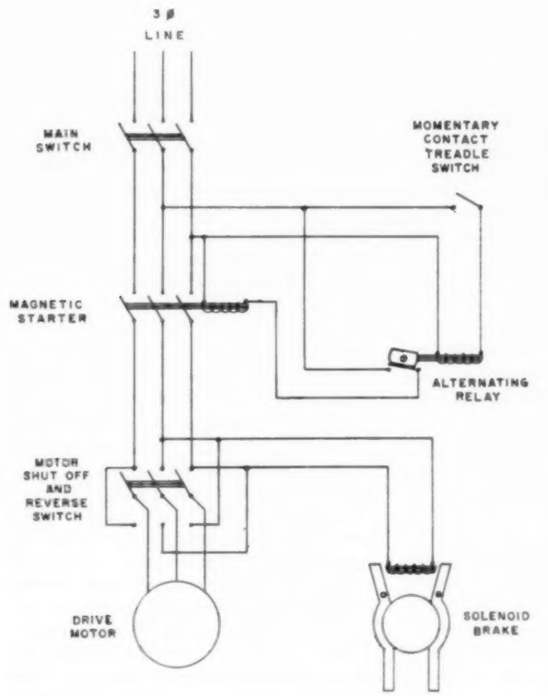

Fig. 2. Diagram of system showing how closing treadle switch (upper right) starts series of operations.

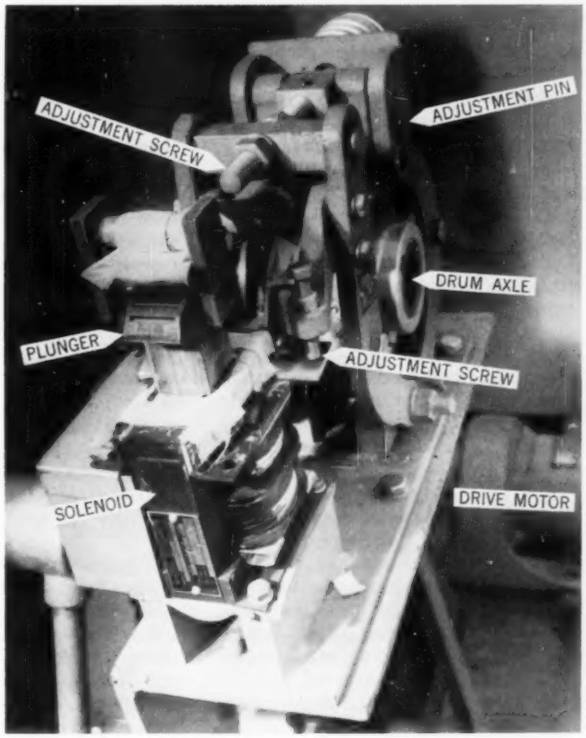

Fig. 3. Solenoid brake system.

to produce the cleanest film at a reasonable cost and with the least risk to negative, is cleaning by hand on a drum. This is the procedure used by the West Coast Division of Pathé Laboratories.

The biggest advantage of the drum method is that every foot of the film to be cleaned is conveniently arranged for visual inspection by the drum operator so that he can evaluate the effectiveness of his work as he proceeds. There is not much dirt that gets by a skilled operator. In building our most recent drum, the aim was to enhance this advantage. The inspection and hand-cleaning facilities were made as convenient as possible. All other necessary operations were made unobtrusively automatic to lighten the load on the operator.

Design Requirements

In order to minimize influx of dirt, the room in which the drum is located must be out of the way of production traffic, and incoming air must be clean. Keeping the air clean is quite a sizable problem, since the air-conditioning system provides an air change in the room at $\frac{1}{2}$-min intervals. This large flow of air is necessary for two reasons, to carry out the dirt that is removed from the film, and to dilute the cleaning fluid fumes. To handle this requirement, a large portion of one wall was removed and replaced by banks of air filters. Since the cleaning fluid is explosive, all electrical equipment in the room is explosion proof, the cleaning fluid is contained in safety cans, in quantities of not more than one gallon at a time, and dispensed by means of special devices.

Static electricity is minimized by maintaining the air at a relatively high humidity. It has been noticed that a person wearing shoes with rubber, sponge rubber, or composition soles seems to retain static electricity; therefore operators are advised to wear only leather soled shoes. It is a good idea to provide an electroscope in the drum room, so that the operator can check for static electricity occasionally.

During the operation of loading and unloading the drum with film, the drum is driven by a motor at 35 rpm, but the drum is turned by hand while the film is being inspected. The cleaning operation requires that the drum be turned both by hand and by motor at various times. Meeting these specifications requires the drum to be as free turning as possible.

Construction

The dimensions of the drum are rather large — 12 ft long by 5 ft in diameter. To make this 1600-gallon barrel easy to turn, we concentrated all the strength, and the accompanying weight, near the center. Two-and-one-half inch Shelby tubing was used for the axle. This axle was mounted in pillow blocks on a sturdy A-frame, which in turn was anchored through the floor. At one end of the axle, between the drum and the pillow blocks, space is provided for mounting a 24-in. diameter pulley. At the extreme end of the axle, outboard of the pillow block, a solenoid brake is mounted. This brake is constructed so that application of power releases it and shutting off the power engages it. The stopping torque can be controlled by adjustment.

The outer surface of the drum was fastened to the axle by five plywood disks, each the full diameter of the drum. The disks were anchored to the axle by large cast-aluminum spiders. The pattern for these castings was made available by Consolidated Film Industries who had just completed a similar drum. The cylindrical surface of the drum was made of pitch-free pine boards, $\frac{3}{8}$-in. thick and 2-in. wide, running the full length of the drum. The addition of these boards was one of the last steps in the drum construction and it was then possible to sand them down to a perfect cylinder by using the drum as its own lathe. Covering this surface is a felt padding, and the final finish is a black velveteen cloth.

The choice of pitch-free pine as the outer shell required a great deal of consideration. Film is fastened to the drum by push-pins, the outer shell must be able to hold these pins firmly, require no maintenance for years, and be light enough to make turning the drum easy. Rubber on a sheet metal skin had been

tried for this job, but rubber is subject to cold flow, and requires maintenance and occasional replacement of a section. A drum made of wood had been in operation for twenty years with no maintenance of the surface, and this record was deemed an excellent recommendation. The completed drum is shown in Fig. 1.

To drive the drum we have a $\frac{1}{4}$ hp, explosion proof, gear reduction electric motor. There is further speed reduction in the belt drive to the axle. There are no worm gears in the reduction system, so that the motor need not be uncoupled from the drum for hand turning. In spite of the 50-to-1 speed reduction, the motor is so free turning that the drum turns easily by hand.

Operating control is by means of the foot treadle shown running the length of the drum in Fig. 1. Pressing the treadle once releases the brake and starts the motor and pressing it again stops the motor and engages the brake. Reversing the motor for unloading, or shutting off the motor for hand turning is effected by a three-position switch on the wall next to the drum. The electrical diagram of this system is shown in Fig. 2.

Stopping the drum when the end of the film roll is reached, either in loading or unloading, demands a precision braking system, so that the film does not get away from the operator and become damaged. We already have a drum which has a mechanical braking system, where the stopping force is under the control of the operator. The harder he presses on the treadle, the faster the drum decelerates. This has several disadvantages. It requires physical effort from the operator, which becomes very tiring in an eight-hour shift. Also it requires the operator to turn his attention away from the film for a second or two while he judges the braking speed. To reduce this time, the operator has a tendency to stop as fast as he can, and when a 200-lb man puts his full weight on the brake the wear and tear on the system is excessive. To avoid this we used a 75-lb-ft electric solenoid brake (Fig. 3). A mere touch of the treadle is all that is required to set the brake. The operator's judgment is limited to deciding when to press the treadle; once this is done the action is beyond his control, and the stopping speed is constant. With experience, the operator can trip the brake so that the drum stops within inches of the end of the roll.

Operation

To load the drum, the operator mounts the roll of negative on a spindle, which he holds in his hand. The end of the roll is attached to the drum, the drum is started by pressing the treadle, and the film is guided onto the drum as it turns. As the other end of the roll comes up, the drum is stopped, and that end is attached to the drum. Then the motor shut-off switch is opened and the brake released. The operator cleans the film on the section of the drum available to him by hand rubbing with a velvet cloth saturated with a cleaning solvent. After this section is cleaned, the drum is turned by hand until a new section is in place, which is rubbed down in the same manner. This is repeated until the drum has gone through one complete turn. To clean the other side of the film, the operator removes one end of the film from the drum, gives it a half-twist, and re-attaches it to the drum with about two feet of slack. The motor shut-off switch is closed and the drum started, and the half-twist is moved through the length of the film while the operator holds the slack away from the drum with his cleaning cloth. When the new side of the film is exposed, it is cleaned in the same manner as the first side.

To remove the film from the drum, the motor switch is reversed and the drum started. As the film comes off the drum, it is taken up on a film rewind mounted on a cart. The cart moves parallel to the drum, and is pushed by the operator so that it follows the film which is unwinding from the drum.

The drum will hold about 1200 ft of 35mm film. The complete cleaning of a drum-load requires from 15 to 25 min, depending on how much cleaning is required. One drum can handle 3000 to 4000 ft of film per hour.

The drum has been in operation for over a year. At first the 60-cycle hum from the brake annoyed occupants of a nearby projection room but this hum has been damped out by putting adhesive tape around the solenoid coil and plunger.

With this problem resolved, the drum has fulfilled all our expectations.

Discussion

Lewis H. Humphrey (Moody Institute of Science): What film cleaner are you using in this machine?

Mr. Brueggemann: We use a special mixture, one of the ingredients being methyl chloroform.

Mr. Humphrey: Do you use chamois in the cleaning process, or some other material?

Mr. Brueggemann: Black velvet is the usual applicator.

Dirt-Free Exhaust Hood for Cleaning Film

By HOWARD F. OTT

Motion-picture film is usually cleaned with materials that require the use of an exhaust hood to prevent any hazard to the operator. In the usual exhaust hood there is a steady influx of air carrying airborne dirt some of which settles on film which has just been cleaned. A dust-free exhaust hood has been developed which utilizes a curtain of filtered air to prevent the entrance of airborne dirt.

In the interest of good industrial hygiene the use of toxic solvents must be made entirely safe. It has been the practice of Eastman Kodak Co. to provide exhaust hood facilities in all operations where these solvents are used. Film cleaning is one of these operations.

An exhaust hood for cleaning motion-picture film must have an open front for accessibility and must be of sufficient size to accommodate film supply, winding equipment, equipment for cleaning and, of course, an inspection light. Since toxic solvents are commonly used in the actual cleaning process, there is a slot, usually at the base of the rear wall of the hood connected by duct work to an exhaust fan. The quantity of air that must be drawn through the hood to prevent the escape to the room of more than a certain tolerable amount of the toxic solvent depends on the air currents set up in the hood and upon the nature of the solvent. For instance, carbon tetrachloride is poisonous and the poisonous effects are cumulative so that the room contamination must not exceed the maximum allowable concentration of 25 parts per million.* On the other hand, methyl chloroform can be tolerated to a maximum concentration of 500 parts per million.* It is, however, usually the intention of the hood designer to keep the contamination far below the safe limits by providing for much more air flow and perhaps less accessibility than might be optimal.

Cleaning film in an exhaust hood has its drawbacks as well as its benefits. Chief among the drawbacks is a continuous flow of air from the surrounding room over the film to the exhaust slot. This air is usually laden with dirt and lint, some of which settles on the film which has just been cleaned. Much can be done to reduce the amount of dirt carried over the film, such as filtering the room air, having the operators wear protective clothing, and providing good housekeeping conditions. However, some of these measures are expensive, require constant operator cooperation, and are, in the end, often only partially effective.

An experimental hood has been built to overcome this difficulty. With this film-cleaning hood the flow of dirt-laden air into the hood is eliminated. Thus, regardless of the amount of dirt in the air of the surrounding room, none is allowed to enter the hood to settle on the just-cleaned film. The basic idea of the hood is relatively simple and is based on the principle of supplying a greater amount of clean filtered air at the mouth of the hood than can be exhausted at the rear of the hood. Factors complicating the design are the need for uniform air flow, for freedom from turbulence and for elimination of aspirator action. A poorly directed air stream would produce turbulence that would cause dirty air to be mixed with the clean air. Also, air crossing the front of the hood could cause an aspirator action that would allow fumes to escape to the room air. Without a uniform air flow it would be difficult to control these factors. The design chosen effectively eliminates these complications.

Figure 1 is a photograph of the hood. Air is supplied from the room. Ideally it should be taken as high as possible in the room, where there is less airborne dirt. The fan supplies the air under slight pressure to the plenum at the top of the hood. Duct sizes and positions are selected with the aim of making the downward flow of air from the plenum as uniform as possible.

Figure 2 illustrates the flow of air from the plenum. Because the filter has an evening effect on the air flow, it is placed at the outflow side of the plenum chamber. Three inches of glass fiber have been sufficient to remove all particles of objectionable size. Immediately below the filter is an egg-crate-like structure that forms a large number of tubes, 1-in. square and $4\frac{1}{2}$ in. long. The air velocity through these tubes or straightening vanes is around 450 ft/min or $7\frac{1}{2}$ ft/sec. With each tube directing an air stream downward there is formed an effective sheet of air with almost no turbulence. The sides of the hood are brought as far forward as the front of the chamber containing the straightening vanes. The floor of the hood is brought approximately opposite

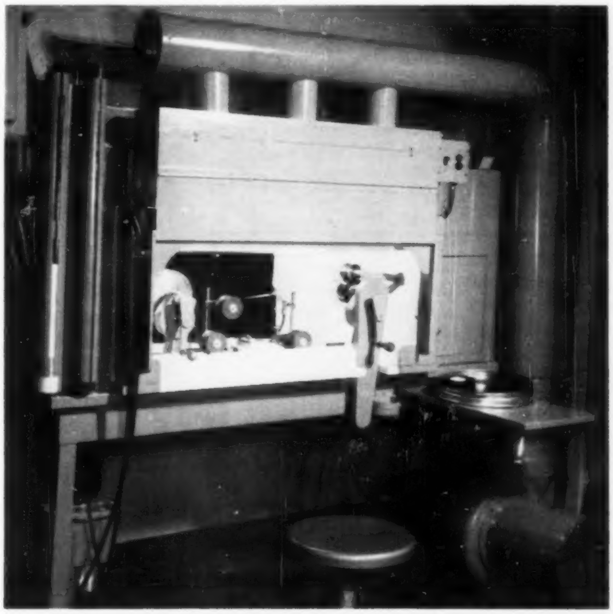

Fig. 1. **The exhaust hood; fan at right supplies air to plenum at top of hood.**

Presented on April 23, 1958, at the Society's Convention in Los Angeles by Howard F. Ott, Color Technology Div., Eastman Kodak Co., Rochester 4, N.Y.

(This paper was received on June 19, 1958.)

* American Conference of Governmental Industrial Hygienists, 1957 listing, published by the American Medical Association Archives of Industrial Health.

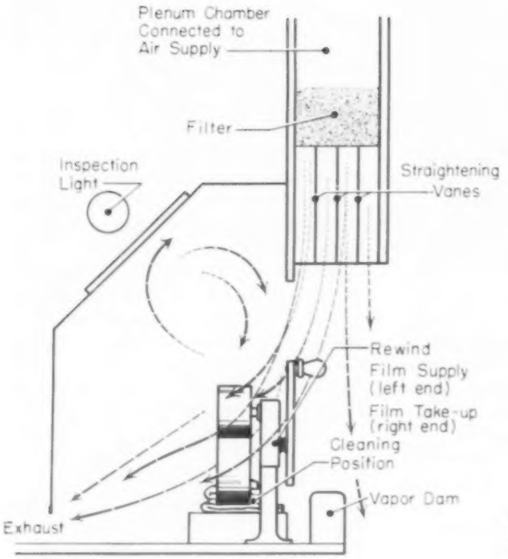

Fig. 2. Flow of air in the hood.

the center of the straightening-vane chamber and carries at its front edge a vapor dam. The vapor dam more importantly serves to shorten the distance the sheet of air must travel in the open and to eliminate the aspirator effect. It also serves as a hand- or arm-rest for the operators while cleaning film.

The exhaust port at the rear of the hood was constructed in three parts so that by adjusting each section in relation to the other two sections an even flow of air through the hood could be obtained. The total air volume supplied at the top of the edge of the hood is approximately 400 cu ft/min. The air exhausted is adjusted to approximately 300 cu ft/min. The sheet of air we have so carefully obtained splits in its downward travel so that three-quarters of it flows smoothly over the equipment inside the hood to the exhaust port and the other one-quarter flushes any dust, dirty air, or lint from the operators' clothes downward past the front of the hood.

In order to evaluate the effectiveness of the ventilating system, tests were made using carbon tetrachloride for film cleaning. Carbon tetrachloride is the most volatile and the most toxic solvent likely to be used for this purpose. A Davis-Halide meter was used which had previously been calibrated for carbon tetrachloride vapor. The sensitivity of this instrument toward this vapor is in the range of two to five parts per million. The author is indebted to E. C. Riley, R. F. Scherberger and F. A. Miller of Kodak's Industrial Medical Department for these tests and their valued comments. Their report states: "Tests made at the nose level of an operator seated in front of the hood showed no carbon tetrachloride vapor to be present. In fact, no vapor could be found anyplace within the hood except in the air stream between the carbon tetrachloride wetted wipe pad and the exhaust slot at the rear of the hood. No carbon tetrachloride was present in the general room air during or after the 15-minute run." This test was made using carbon tetrachloride for the reasons given, but it should not be inferred that this solvent is currently recommended. The solvent normally used for film cleaning in our laboratories is inhibited methyl chloroform because of its much lower toxicity. The subject of film cleaning and the choice of suitable solvents has been discussed by Fassett, Kolb and Weigel in a paper presented before this Society (pp. 572–589 of the *Journal* for September 1958).

The effectiveness of the hood in keeping airborne dirt off the film is impressive. The hood is installed in a room on a main corridor where airborne dirt has always been a problem. When the clean air supply is turned on, dirt does not deposit on film in the hood; but as soon as the supply of clean air is turned off, objectionable quantities of dirt can be seen depositing on the film. The overall effectiveness as seen on the screen is considerably masked because dirt and dust can deposit on the negative and print stock any time from opening the can of raw film up to and including the projection. This hood is one step in the direction of obtaining clean prints. The hood described was built for a specific installation to meet specific requirements. The principle, however, can be extended or perhaps altered to suit the requirements of other installations or applications. We are considering using the principle further to envelop printers and rewinding areas with local environments of recirculated filtered air

16mm Super Anscochrome Films

By JOHN L. FORREST

16mm Super Anscochrome Daylight Type 225 was introduced in 1957 and Super Anscochrome Tungsten Type 226 was introduced early in 1958. Each of these types of film has an exposure index of 100 with normal processing. This high speed makes possible the production of motion pictures in full color.

THE SPEED AND GENERAL characteristics of 16mm reversible camera films remained relatively static for a number of years until 1954 when Anscochrome first made its appearance on the photographic market. With an exposure index of 32, it was more than twice as fast as other color films available at the time of its introduction. This faster color film was found useful by commercial producers and amateurs for "hard to get shots" where light was a problem.

It was soon discovered that another stop or two in speed could be squeezed out of the product by process manipulation. The general interest in forced processing prompted the study described in a paper which points out that, while it is possible to secure a speed increase by forced processing, certain disadvantages are associated with this technique, such as steepening of gradation and increased granularity.[1]

In 1957 Super Anscochrome 16mm film was introduced. This new film has the increased speed built in with no sacrifice in quality caused by forced processing. The film is made in two types, one balanced for daylight and the other balanced for tungsten illumination. The exposure index of each type is 100 when processed by the normal recommended processing procedure (Tables I and II). This is believed to be the fastest reversal color film available anywhere today and exceeds the speed of many black-and-white films. This speed is secured without the usual disadvantages associated with speed increase in photographic emulsions. The granularity has not been increased perceptibly, and there is no sacrifice in curve conformity. The film carries the usual one-year dating without requiring refrigerated storage. It is interesting to note that Super Anscochrome, a color film, is more than twice as fast as a black-and-white professional 35mm motion picture film which Ansco introduced in 1937 which, at that time, was acclaimed as the fastest black-and-white camera negative film.[2] The film was awarded an "Oscar" by the Academy of Motion Picture Arts and Sciences for its speed achievement.

Presented on April 24, 1958, at the Society's Convention in Los Angeles by Harold Jones for the author, John L. Forrest, Motion Picture Development Laboratory, Ansco, Binghamton, N.Y.
(This paper was received on April 18, 1958.)

Table I. Exposure for Super Anscochrome 16mm Daylight Type 225.

Light Source	Camera Filter	Exposure Index
Daylight	None	100
Photoflood lamps (3400 K)	80B	40
*3200 K Tungsten lamps	80B	40

* Emergency use only.

Super Anscochrome, with its exposure index of 100, is faster than most black-and-white films on the market today, and equal in speed to all but the fastest. This extreme speed makes it possible to make pictures in full color where previously only black-and-white pictures could be made. It reduces the amount of light necessary to expose a scene and in many cases it makes supplementary lighting unnecessary. Usually, the normal lighting used for television, sporting events, entertainment shows, etc., is adequate to give full exposure. In motion-picture work, with light levels as low as 2 candle-power/sq ft and with the usual lens equipment provided on motion-picture cameras, satisfactory exposure can be obtained. Large areas, such as the interior of factories and plants, which were once difficult if not impossible to photograph, can now be recorded on color film under the normal factory lighting. Newsreel coverage, which heretofore was confined to black-and-white film because of light restrictions, can now be made in full color. This makes color TV newsreels entirely practical.

Super Anscochrome 16mm Tungsten and Daylight motion-picture films are similar in characteristics except for their color balance. One is balanced for daylight and the other for tungsten (specifically 3200K) illumination to give correctly balanced colors under studio lighting (Fig. 1). It is recognized that the daylight type film is much too fast to be used with certain camera equipment. For instance, a normal outdoor scene illuminated by sunlight would require a lens stop in the order of $f/32$, which is several stops below the smallest diaphragm opening found on the average lens. In such a case, a neutral density filter will be useful.

Table II. Exposure for Super Anscochrome 16mm Tungsten (3200 K) Type 226.

Light Source	Camera Filter	Exposure Index
3200 K Tungsten Lamps	None	100
Photoflood lamps (3400 K)	81A	100
"CP" lamps (Approx. 3350 K)	81A	100
Daylight	85B	80

For the advanced amateur or professional using a camera with a variable shutter, the high-speed film has many advantages, such as making possible exposure with better motion stopping and sharper, clearer, pictures. The tungsten-type film is preferable for many purposes in indoor photography where insufficient lighting is a problem.

Characteristics of Super Anscochrome

Except for the higher speed, the general characteristics of Super Anscochrome are similar to Anscochrome. Characteristic curves of the film are shown in Fig. 2. Processing is in accordance with the procedure published earlier.[1] It will be noted that the film has a rather long, straight, line characteristic; nevertheless, it is recommended that the exposure be kept within $\pm\frac{1}{2}$-stop of normal. This is particularly important if prints or duplicates are to be made from the original. It is also advisable to keep the brightness range between a 1:2 and 1:3 highlight-to-shadow ratio. Where scenes are to be photographed without supplemental lighting, there is little control of the light-to-shadow ratio, but with modern indoor lighting technique, it is surprising how few scenes exceed the range which can be covered by the film. This is most evident where fluorescent lighting is used.

For areas illuminated by "Daylight Type" fluorescent tubes, Daylight Type Super Anscochrome will give the best result, although all daylight fluorescents will produce pictures somewhat on the cold side. Such fluorescent illumination is "cool," and to reproduce it otherwise would be incorrect.

White fluorescent illumination falls between daylight and tungsten in color temperature, with a somewhat different spectral distribution than either of these sources. The film choice, however, would be Daylight Type with a filter CC-10B likely to give the best color balance with no change of exposure. There is no completely satisfactory correction filter for fluorescent illumination, because of the nature of the source.

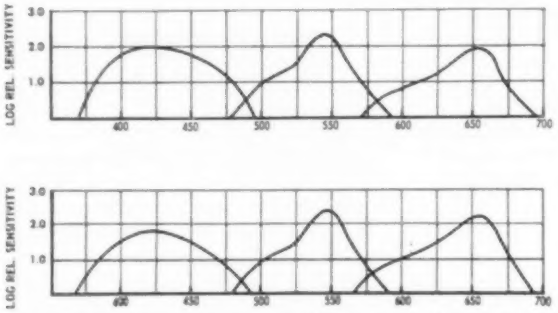

Fig. 1. Relative sensitivity curves of Super Anscochrome Tungsten Type (top) and Daylight Type (bottom); wavelength in millimicrons.

It is too soon to give definite data on latent image stability, but tests which have been under way for six months on production emulsions show excellent stability in all three layers with little or no color shift and negligible regression. So far, these tests parallel Anscochrome, which shows good latent image stability over a two-year period when stored at 72 F and excellent latent image stability when stored for the same time at 0 F. It can be predicted from these tests that the film will show negligible latent image color shift or regression under normal working conditions.

Super Anscochrome film has little reciprocity law failure,[3] particularly in the short exposure range, which makes it unnecessary to use compensating filters, even for high-speed photography (Fig. 3).

The dyes (Fig. 4) produced by dye-coupling development are similar in all Anscochrome type films. They have been purposely made this way so that they can be interspliced and printed on the same type duplicating stock. The duplicating stock is Ansco Color Type 238, and the sensitivity peaks of this stock are matched to the transmission of the Anscochrome dyes (Fig. 5), which facilitates subtractive printing when prints or duplicates are desired.

The grain of Super Anscochrome and Anscochrome is similar in distribution and size. It is not as fine as that of Anscochrome Professional Film, Type 242,[4] which is roughly half the speed of regular Anscochrome and has about one-sixth the speed of Super Anscochrome. In production work the combination of Anscochrome Professional Film and Super Anscochrome makes a good team when Anscochrome Professional Film is used for scenes where lighting is not a problem and Super Anscochrome for the hard-to-light scenes.

The general color characteristics of the two films are such that they lend themselves to intersplicing in printing without noticeable color shift in the final print. When intersplicing is contemplated, it is important that the perforation types match. Super Anscochrome is made in both standard and so-called short pitch perforation. Anscochrome Professional Film is available only with short pitch, since it is primarily a professional camera stock intended for use where prints or duplicates are required.

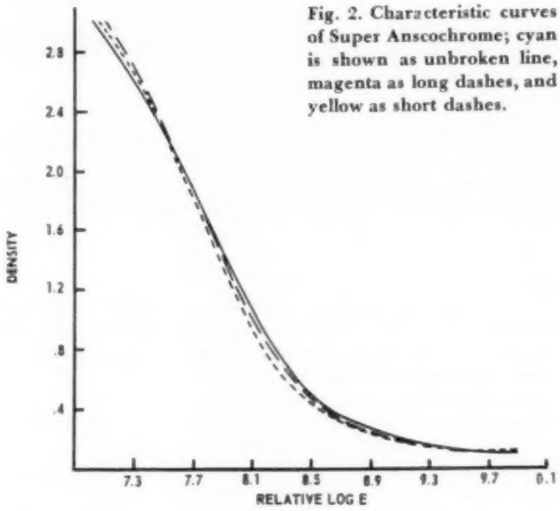

Fig. 2. Characteristic curves of Super Anscochrome; cyan is shown as unbroken line, magenta as long dashes, and yellow as short dashes.

(At the Convention a demonstration reel was projected to show the variety of subjects which have been photographed without supplemental lighting.)

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2. P. H. Arnold, "Sensitivity tests with an ultra-speed negative film," *Jour. SMPE, 30:* 541–558, May 1938.
3. A. F. Gifford and F. H. Gerhardt, "Characteristics of Super Anscochrome Film," *Photo Sci. and Eng., 1:* 12–14, July 1957.
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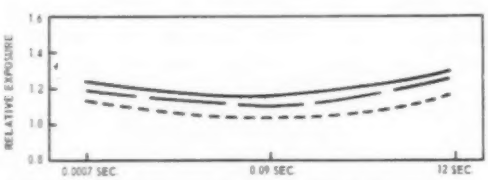


Fig. 3. Reciprocity sensitometry: Film is Super Anscochrome; density level, 0.70 gross; color temperature, 3200 K; development, normal reversal. Red = unbroken line, green = long dashes, and blue = short dashes.

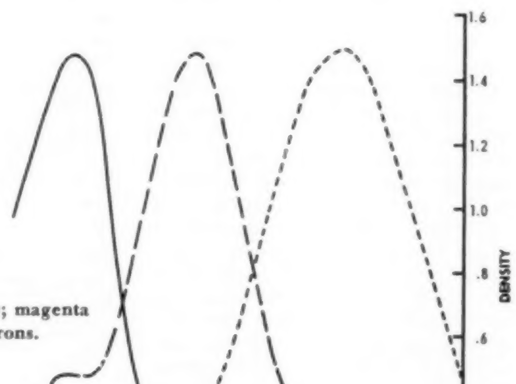


Fig. 4. Absorption curves of dyes; yellow shown as unbroken line; magenta as long dashes, and cyan as short dashes; wavelength in millimicrons.

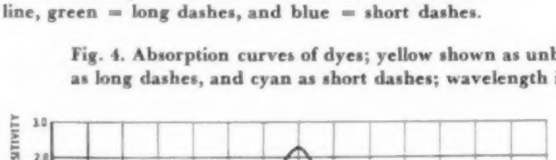


Fig. 5. Relative color sensitivity curves of Ansco Color 16mm Duplicating Film Type 238; wavelength in millimicrons.

Discussion

Neil Kaplan (Ramo-Wooldridge Corp.): What results do you get with tungsten film under fluorescents?

Harold Jones (who read the paper): It depends somewhat on the type of fluorescent light. If the fluorescent bulbs are the daylight type, it is preferable to use Daylight Type Super Anscochrome film. When you get into fluorescent illumination of the type which is white or between daylight and tungsten in color balance, the film choice should also be daylight type, but here a CC-10B filter should be used. Generally speaking, for fluorescent lighting, the results obtained on the tungsten balanced film will probably not be as satisfactory as on daylight balanced Super Anscochrome film.

J. K. Lewis (Dept. of Defense, Fort Meade, Md.): Do I understand that your film is being released in 70mm in the near future?

Mr. Jones: That is correct.

Mr. Lewis: Are you planning also to release 16mm width perforated for splitting to 8mm?

Mr. Jones: It is not our intent to do that, except that the film will, of course, be available with the 8mm-type perforation for high-speed camera use.

Joseph Dephoure (Dephoure Studios): Is this film also available in single-perforated stock for sound recording?

Mr. Jones: Yes, it is.

Improvements in the Blown Arc for Projection

By RUSSELL J. AYLING and ARTHUR J. HATCH

The air-blown carbon arc has been further refined by the use of a noncoated graphite rod negative which is rotated to reduce carbide deposits to a minimum. Design of components has been simplified to facilitate maintenance and servicing. Controls have been simplified for ease of operation in the theater. The advantages of the infrared transmitting reflector and new 25-in. positive carbon have been consolidated in this development.

During the past several years the trend has been toward wider screens for projection, especially in drive-in theaters. In some drive-in theaters the screens have been widened to as much as 150 ft. Screens less than 100 ft in width show reasonable light intensities with present arc equipment, particularly since the usual practice is to reduce the projected picture to about 80% of the screen width with nonanamorphic prints. Nearly half of all drive-in screens are 100 ft, or more, in width, and it is with these that the intensity of illumination falls so low that in many cases it is impossible to distinguish action on the screen when the film density is high.

The blown arc developed by Gretener[1] provides a means of burning a high-brightness carbon at an extremely high-current density and in a manner such that a high-collection efficiency can be realized.

With this technique, the arc is constricted by small air jets arranged in concentric circles around the positive carbon and directed toward the tip of the carbon. A cylindrical (three dimensional) light source is obtained making possible the use of a much larger light pickup angle than would normally be available from a conventional arc with its shallow disk-shaped source. Because of the extended shape of the source an auxiliary reflector in conjunction with the main reflector can be utilized effectively. A current-carrying coil surrounding the positive carbon introduces a magnetic field and helps to homogenize the arc and keep the current steady.

Greider[2] reports performance tests comparing a blown arc and a conventional arc, each with the same core and crater size. Results of these tests indicate that the maximum source brightness figures are essentially the same, although the blown arc has a much more uniform brightness distribution across the source. This accounts for a higher average source brightness resulting in more lumens on the screen. When adjusted for the same average brightness of source, the power requirements for the blown arc are 15% to 20% less than for the conventional arc.

The New Blown Arc

The incorporation of Gretener's basic ideas together with a simplified design and other improvements has resulted in a new blown arc lamp capable of practical application in theaters where high light volumes are required. The overall dimensions of the new blown arc lamphouse (Fig. 1) are 45 in. long by 29 in. wide by 43 in. high. This large cubic volume is essential to keep the lamphouse relatively cool. A twin pressure blower mounted under the top cover supplies 3 cu ft/min of air at a pressure of $3\frac{1}{2}$ in. water to the positive jets, and 100 cu ft/min of exhaust capacity to the suction tube for eliminating all soot and smoke from the lamphouse.

A large hinged door is provided on the operator's side to allow greater access to the inside of the lamphouse. This door is equipped with two filtered viewing glasses which provide for observation of the arc and surrounding areas while the lamp is burning. A large arcescope screen is located at the top front on the operator's side. A magnified image of the arc is sharply focused on this screen for convenience to the operator in viewing the carbon position.

The simplified 10mm nonrotating positive water-cooled head (Fig. 2) consists of (1) silver contacts with jet holes, (2) auxiliary reflector, (3) magnet coil and (4) removable feed rollers. The silver contacts and auxiliary reflector are easily removable for replacement.

The main reflector mounting frame and negative head are an integral part of the rear door which swings open for easier servicing of the lamp (Fig. 3). The reflector is mounted to the frame with four removable clips. These clips are lined with silicon rubber which will withstand very high temperatures, and also act as a cushion to relieve the reflector of any shock or strain caused by mounting. The main reflector assembly is designed to move along a horizontal axis for proper focusing of the reflector. It can be refocused to conform to the high distribution requirements of any film width. This movement is controlled by a knob at the front end of the lamp. Reflector tilt knobs project through the back end of the rear door for balancing of screen light from side to side.

To accommodate a full 21-in.-diameter reflector, the optical center line of the lamp was raised to $14\frac{3}{16}$ in. above the mounting-table surface. This necessitates a special pedestal or a modification of existing pedestals for optical aligning of the lamp to the projector.

The lamphouse and reflector are completely air-conditioned by a series of ventilation holes in the housing and by an exhaust port at the top of the lamphouse,

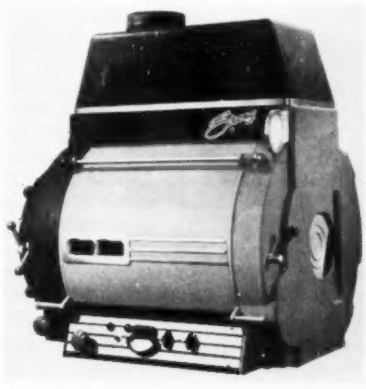


Fig. 1. Blown arc lamphouse.

Presented on April 24, 1958, at the Society's Convention in Los Angeles by Russell J. Ayling and Arthur J. Hatch (who read the paper), Strong Electric Corp., 87 City Park Ave., Toledo, Ohio. (This paper was received on April 18, 1958.)

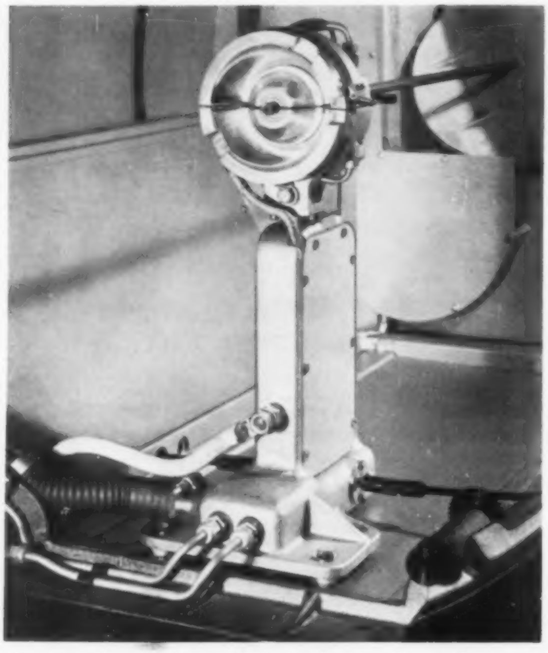


Fig. 2. Positive head assembly showing auxiliary reflector and contacts with air jet holes.

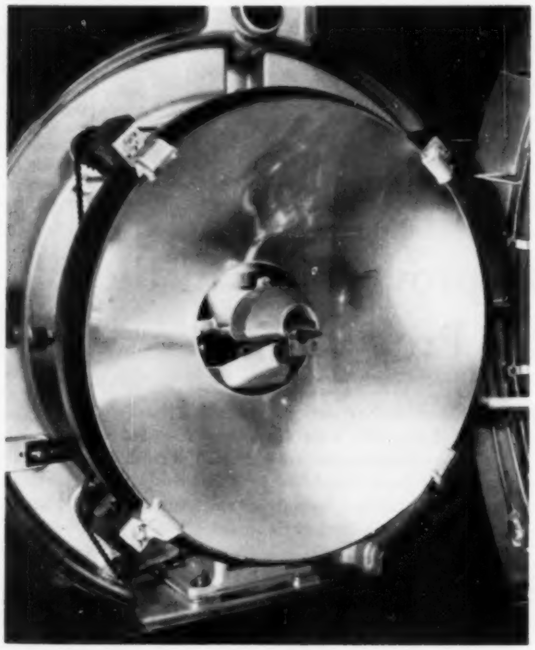


Fig. 3. Reflector and negative head mounted on rear door.

Fig. 4. Flame configuration of blown arc with rod-type negative.

leading directly to the discharge stack. An instrument panel is conveniently located on the operator's side for fingertip control of the arc. This panel contains (1) an ammeter, (2) arc power switch to energize the rectifier, (3) arc power selector rheostat, (4) arc current selector rheostat and (5) positive and negative feed indicator lights.

Improved Negative-Carbon Feed Head

Extensive tests have determined that the rotating disk negative is not entirely suitable for theater use to obtain the ultimate in maximum light projection and stability and where long continuous operating periods are not necessary. For one thing the disk, over a certain period of time, attains an irregular or wavy edge which seriously affects current and light stability. This irregular edge is primarily caused by periodic striking of the arc and uneven burning of the disk. This problem could be solved by incorporating a disk edge grinder in the lamphouse; however, such equipment is bulky and does not fit into a simplified design scheme. Also, the disk negative creates a rather large shadow area on the main reflector resulting in a substantial decrease in the useful light that would normally be reflected to the film aperture. As an alternate to the disk negative, tests were conducted on a great variety of rod-type negatives. Working in close cooperation with the National Carbon Company, a solid graphite uncoated carbon $\frac{7}{16}$ in. in diameter and 12 in. long was finally selected as the most practical for blown arc operation. The burning rate of this carbon varies from 6 in. to 8 in. per hour depending on the current selected.

As shown in Fig. 4, the rod negative tip, with proper arc gap, is positioned in approximate horizontal alignment with the lower edge of the positive carbon tip so that the arc flame strikes only the tip of the negative. In this position the negative angle from the horizontal is approximately $8\frac{1}{2}°$. This angle can be adjusted slightly be means of a screw alignment. Another screw adjustment assures sideways alignment of the negative. Rotation of the rod negative at 2 to 5 rpm assures a symmetrical tip with essentially no carbide formation. If the negative is positioned too high in the flame, however, there is a chance of carbide forming.

The water-cooled suction exhaust tube is an integral part of the negative head. A silver negative carbon contact is mounted on the bottom surface of the suction tube where it receives adequate cooling. This exhaust-tube/contact assembly is spring-loaded to apply a force on the negative carbon and drive roller for optimum feeding and rotation. Both the negative and positive heads were designed to present a minimum shadow area in the projected beam to the film aperture and the total shadow area has been limited to approximately 12%.

Coupled to the negative head is a manual-control striker which in a single motion strikes the arc and automatically positions the arc gap length to $\frac{1}{2}$ in.

The rate of negative carbon advancement is maintained by an arc-current controlled relay consisting of a sensing coil, bias coil, and single-pole single-throw contact. The sensing coil is connected in series with the arc, while the bias coil is connected in series with the adjustable arc-current selector rheostat, located on the instrument panel and regulates the flux to set the contact balance point for any desired current. The nega-

tive feed motor controlled by this relay has a speed ratio variation of 3 to 1. By this method the arc gap is automatically varied, enabling the arc current stability to be maintained within $\pm 1\%$, except for sudden line voltage fluctuations, or momentary erratic carbon burning characteristics.

Reflector Specifications

The physical dimensions of the elliptical shaped main reflector are $6\frac{1}{4}$-in. focal length, 41-in. working distance, and 21-in. diameter. With an optical speed of $f/1.7$, the reflector efficiently works with the commonly available $f/1.7$–$f/1.8$ projection lenses.

The total light pickup angle of the optical system, including both the 6-in. diameter auxiliary and 21-in. diameter main reflectors, is more than 260° which is approximately 100° more than is possible with a conventional arc system. The arc is almost totally enclosed by the two reflectors and contacts, therefore very little direct radiation from the arc strikes the lamphouse.

The reflector is of glass, cold type, which transmits approximately 50% of the unwanted infrared heat into the back end of the lamp where the energy is dissipated either by radiation or through the exhaust stack. Actually the resultant heat reflected to the center of the film aperture is no greater than when burning an 8mm copper-coated trim type lamp at 70 amp. A two-piece spherical auxiliary reflector with a polished aluminum reflecting surface accounts for 12% to 15% of the total lumens reaching the screen.

A positive carbon tip protrusion of $\frac{3}{8}$ in. is maintained within ± 0.004 in. variation by an automatic positioning control system consisting of a solar cell, transistor amplifier and sensitive relay. These parts are coupled together by an appropriate resistor network (Fig. 5). Arc voltage is applied to the control system through a voltage divider resistor limiting the transistor voltage to 12–15 v d-c.

A side image of the positive carbon is projected onto the solar cell through a narrow light limiting slit. The position of the carbon image on this slit determines the amount of light impinging on this cell. With low light level, the base current to the transistor is essentially zero so the normal arc voltage energizes the sensitive relay, shunting out a 1000-ohm resistor in series with the field of the positive feed motor resulting in a positive carbon feed slower than the burning rate.

As the carbon drifts back slightly the intense light from the carbon crater passes through the slit onto the solar cell increasing the base current which is magnified 30 times through the transistor. This current bucks the normal relay current from the arc voltage source and de-energizes the relay. Opening of the relay contacts removes the shunt and the resistor is placed back in the motor field

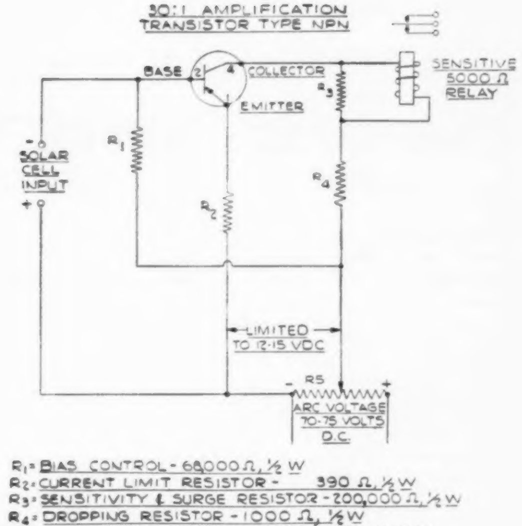


Fig. 5. Positive-carbon positioning control system.

circuit causing the positive carbon feed rate to increase $2\frac{1}{2}$ times over the slow feed rate. The cycling rate is about 15 to 20 times per minute.

Using the new 10-mm diameter by 25-in.-long Ultrex carbon at approximately 155 amp, and 75 v, a double reel of film can be projected with a nominal stub remaining. Alternate carbons which can also be used for projection of a double reel per carbon are the 10-mm by 25-in. Hitex at 137 amp or the 10-mm by 20-in. Hitex at 130 amp.

The new blown arc will deliver up to 46,000 lumens (no shutter) at a minimum in focus center to side distribution of 80% when projecting through a 35mm aperture (0.825 by 0.600) with $f/1.7$ projection lens. This is an increase of 51% in screen light over the most efficient conventional arc system with equivalent projection lenses. For CinemaScope 35mm (0.912 by 0.715) 55,000 lumens is available; 56,000 lumens for M-G-M 65mm and Todd-AO 70mm; and 65,000 lumens for Fox CinemaScope 55mm (1.340 by 1.060).

Power Adjustment Control

A new 220-v, three-phase selenium rectifier has been especially designed for operation with the blown arc. Featuring a magnetic amplifier type of control, the rectifier can now be mounted at any remote position and still assure fingertip power adjustment merely by controlling the arc power selector rheostat mounted on the lamp instrument panel.

It is extremely important that water and air flow continually through the negative and positive heads while the arc is burning. Therefore a water-flow and airflow switch are interlocked to the arc power switch located on the instrument panel and power control relay, located in the rectifier so that the arc will not operate unless these safety devices are satisfied by sufficient air and water.

References

1. Edgar Gretener, "An improved carbon-arc light source for three-dimensional and wide-screen projection," *Jour. SMPTE, 61*:516–524, Oct. 1953.
2. C. E. Greider, "Performance of high-intensity carbons in the blown arc," *Jour. SMPTE, 61*:525–532, Oct. 1953.

Discussion

Farciot Edouart (Paramount Pictures Corp.): What is the noise factor of this new arc in comparison to the conventional-type lamp?

Mr. Hatch: The noise in the booth is somewhat increased by the air blowing on the arc. In experimental installations, the projectionists have noted at first that there has been a little more noise. After two or three nights the projectionists have become used to the noise.

Mr. Edouart. What is the db increase in noise?

Mr. Hatch: We have not made any measurements of the noise.

Archie Herbert (Projectionist, Lincoln Theatre, Los Angeles): What is the relative cost of the new carbon as compared to the standard high-intensity carbon used in the Strong 135 arc?

Mr. Hatch: The figures show that at top performance the cost of carbons for this arc will be a little under \$3.00 an hour and that will range down to about \$1.80 an hour at the lower limit of operation. In general I think you'll find the cost of carbons will be approximately double that of the conventional arcs that you've been using.

Mr. Herbert: What about the mirror reflector with this particular arc? How does it compare with that of the standard? Is there a tendency for the mirror to coat up at the tail flame?

Mr. Hatch: The main reflector remains very clean mainly because the air jets surrounding the positive carbon blow the products of combustion in a horizontal path and into the air suction tube. All of the soot, flame and smoke go into this tube, and the reflector consequently remains very clean.

Mr. Edouart: Has any attempt been made to rotate the positive in addition to the negative? I notice in your projected picture, that the crater edge is very uneven.

Mr. Hatch: In the particular picture that was used of the crater, there is an unevenness on the crater edge which occurred at the point where there is a separation between the upper and lower contacts. However, this unevenness does not cause any difficulty in the stability of the arc or in the light pickup because the actual light source is some distance in front of the positive carbon crater edge. It is for this reason that it is possible to use the auxiliary reflector and obtain a gain in illumination.

news and reports

Progress Report Volunteers

The Progress Report Committee is in urgent need of volunteers to contribute information on various areas of the expanding industries. Three subjects in particular should be covered:

(1) New microphones and techniques;
(2) New lighting techniques; and
(3) Transistor equipment for TV and motion-picture use.

Also, expression of opinion is invited as to other subjects that might be reported upon in future Progress Reports. Anyone who will volunteer to become a member of this important Committee, or who wishes to suggest additional subjects for the Report, is requested to write to the Committee's Chairman, Lloyd Thompson, The Calvin Co., 1105 Truman Rd., Kansas City 6, Mo.

SPIE Meeting

The Third Annual Exhiborama and National Symposium of the Society of Photographic Instrumentation Engineers was held in Los Angeles, July 29–Aug. 1. The program included four classified sessions of which two were confidential and two were secret. The final session, which was classified as secret, included a field trip to the Naval Air Missile Test Center, Point Mugu, Calif., with a tour of the instrumentation and range facilities.

An especially interesting Panel Forum was conducted the afternoon of July 30. Although it was described by the, perhaps misleading, title of "Nonsense-Itometry" it developed into a serious and enlightened discussion of the retrieval and enhancement of the photo image by techniques employing effects associated with the nonlinear regions of the H&D curves. It was recognized that there is a lack of established data on these phenomena, particularly at low exposure levels and intensified development where the behavior of the film is not well defined. Moderator of the Panel was Carlos Elmer, Traid Corp. Panel members were: Norwood Simmons, Eastman Kodak; Hollis Moyse, du Pont; Ed Dowell, Gaevert; and Robert Harbison, Ilford.

Unclassified sessions were recorded and duplicate tapes ordered in writing at the time of the meeting are the means by which SPIE publishes its proceedings. Further information is available from SPIE Secretary, Stanley E. Baker, 8321 Keokuk Ave., Canoga Park, Calif.

Education, Industry News

A course in *Magnetic Video-Tape Recording of Television* (806ABC) is being conducted by the Engineering Extension of the Univ. of Calif., Los Angeles 24, in cooperation with SMPTE. The series of 18 weekly lectures began Sept. 24 and will continue through Feb. 4, 1959. Instructors are: John T. Allen, Supervisor of Television Recording, ABC, Hollywood; Charles Anderson, Development Engineer, Ampex Corp. Redwood City, Calif.; Fred Gayton, Video-Tape Maintenance Eng., CBS Television City; Wayne Johnson, Mincom Div., Minnesota Mining and Mfg. Co., Los Angeles; William McDaniel, Branch Manager, RCA Service Co., Burbank, Calif.; Russ Nies, Video-Tape Eng., NBC, Burbank, Calif.; William Powell, Training Administrator, Western Region, RCA Service Co.; William Stanton, Instructor in Electronics, Orange Coast College, Costa Mesa, Calif.; Martin Thibeau, Video-Tape Maintenance Eng., ABC, Hollywood; Robert A. Von Behren, Manager of Research and Development, Magnetic Products Div., Minnesota Mining and Manufacturing Co., St. Paul, Minn.

Titles of the lectures and dates are: Review of Fundamental Electrical Circuit Concepts, Sept 24; Review of Magnetic Recording Theory, Oct. 1; Modulation and Demodulation Principles, Oct. 8; Monochrome Television Signal Formation, Oct. 15; Color Television Signal Formation, Oct. 22; Magnetic Recording Systems Requiring High Tape Speed, Oct. 29; Introduction of the Ampex System of Video-Tape Recording, Nov. 5; Modulation and Demodulation in Video-Tape Recording, Nov. 12; Rotary Head Switching Techniques, Nov. 19; Servo Control Systems Employed in the Ampex VR-1000 Videotape Recorder, Nov. 26; Audio System Employed in the Ampex VR-1000 Videotape Recorder, Dec. 3; Electronic Conversion to Color Recording with the Ampex VR-1000 Videotape Recorder, Dec. 10; General Description of the RCA TRT-1AC Video-Tape Recorder, Dec. 17; Modulation and Demodulation Techniques Utilized in the RCA TRT-1AC Video-Tape Recorder, Jan. 7, 1959; Color Processing Techniques in the RCA TRT-1AC Video-Tape Recorder, Jan. 14; Field Trip to NBC Burbank Video-Tape Plant, Jan. 21; Parameters of the Video-Tape Medium Affecting Picture and Sound Quality, Jan. 28; Editing Techniques and Commercial Applications of Video-Tape Recording, Feb. 4.

Course Coordinator is Ralph E. Lovell, Assistant Video-Tape Supervisor, National Broadcasting Co., Burbank, Calif.

R. Edward Warn, Vice-President and General Manager of Westrex

Completed purchase of Westrex Corp. from Western Electric Co. by Litton Industries Inc., 336 N. Foothill Rd., Beverly Hills, Calif., has been announced. Preliminary negotiations were made last spring (*Journal*, May 1958, p. 350). At that time it was announced that the purchase would be completed after agreement had been reached on such matters as patent license arrangements and continuation of the Westrex Employee Benefit Plan.

Under terms of the final agreement Westrex has become the outlet for a line of tropospheric and ionospheric scatter relay equipment for over-the-horizon communication and a new line of communication power wire and cable. Other Litton communication equipment will be distributed through Westrex's 19 foreign offices.

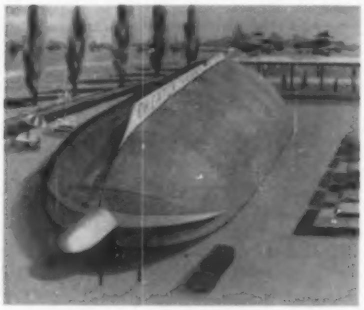
Members of the Westrex Board are: R. Edward Warn, Harry Allinsmith and Roland Colistra, from the Westrex organization; Charles B. Thornton, President and Chairman of Litton, and Roy L. Ash, Glen McDaniel and Fred Sullivan, Litton Vice-Presidents. Mr. McDaniel is now President of Westrex and Mr. Warn is Vice-President and General Manager. Frank A. Ungro, who was Executive Vice-President of Westrex under Western Electric ownership, has been named Assistant Treasurer.

The sale was approved by the U.S. District Court of New Jersey in accordance with the findings of the court in the case of U.S. vs. American Telephone and Telegraph Co. and Western Electric, Jan. 24, 1956.

Westrex employs more than 1200 persons, 1000 of them overseas; an assembly plant is maintained in England. The firm's gross income for 1957 was $13,000,000.

The Artiscope animation process will be used by the East Coast Studios of Westworld Artists Productions Inc., 41 W. 57 St., New York, for cartoon series and feature length cartoon films. The process makes use of specially photographed and processed film which is converted into line images.

Axel G. Jensen, SMPTE Engineering Vice-President, has been made a Knight of the Order of Dannebrog by King Frederick IX of Denmark, in recognition of his work as a scientist and as an expression of appreciation for his assistance to Danish scientists and engineers who have visited the United States. For more than five centuries the Order of Dannebrog has represented the highest civilian honor that can be bestowed by the King of Denmark. Dr. Jensen, who is Director of Visual and Acoustics Research, Bell Telephone Laboratories, Murray Hill, N.J., was born in Copenhagen, Denmark, and was graduated from the Royal Technical College of Copenhagen with a degree in electrical engineering. He came to the United States in 1921 for post-graduate work at Columbia University. In 1922 he joined the Engineering Dept. of Western Electric Co., which later was incorporated as Bell Telephone Laboratories. Honors bestowed in recognition of his scientific achievements include the SMPTE David Sarnoff Award and the G. A. Hagemann Award for Industrial Research granted by the Royal College of Copenhagen.



A portable auditorium designed by Wilding Picture Productions, Inc., 1345 Argyle St., Chicago, consists of a framework of aluminum ribs or arches covered with canvas. The arches of the structure, called the Portatorium, swing upward and meet in the middle to form a weather-tight shelter for roadshows and other exhibitions. It is custom-made to various specifications. The model illustrated is 180 ft long, 22 ft high and 50 ft wide with a seating capacity of 1000. The price is about $20,000. For heating or air conditioning, a smaller structure fits inside the larger one to provide dead air space for insulation. The structure includes a generator and lighting fixtures and is designed so that it can be transported on a trailer truck with a second truck for hauling heating or air-conditioning equipment.

The 12 best films of all time as selected by a jury of 117 film historians under the auspices of the Belgian Film Library for showing at the Brussels Exposition are listed below, together with the name of the director, country and year of release: *Potemkin*, S. M. Eisenstein, USSR, 1925; *The Gold Rush*, Charles Chaplin, U.S., 1925; *The Bicycle Thief*, Vittorio De Sica, Italy, 1948; *The Passion of Joan of Arc*, Carl Dreyer, France, 1928; *Grand Illusion*, Jean Renoir, France, 1937; *Greed*, Erich von Stroheim, U.S., 1923; *Intolerance*, D. W. Griffith, U.S., 1916; *Mother*, Vsevolod Pudovkin, U.S.S.R., 1926; *Citizen Kane*, Orson Welles, U.S., 1941; *Earth*, Alexander Dovshenko, U.S.S.R., 1930; *The Last Laugh*, F. W. Murnau, Germany, 1924; *The Cabinet of Dr. Caligari*, R. Wein, Germany, 1919. The 12 best directors, chosen by the same jury, are: Chaplin, Eisenstein, René Clair, De Sica, Griffith, John Ford, Renoir, Dreyer, von Stroheim, Pudovkin, Murnau and Robert Flaherty. It will be noted that three of the "best" directors did not make the "Best Film" list.

At the 10th International Cinematography Engineering Congress held earlier this month in Turin, Italy, the SMPTE was officially represented by Joseph A. Tanney, President of S.O.S. Cinema Supply Corp., New York. Greetings from SMPTE President Barton Kreuzer were transmitted by Mr. Tanney to the Chairman of the Congress, Dr. Ing A. Daniele Derossi. A selection of published material illustrative of the Society's activities was exhibited to Congress visitors under Mr. Tanney's supervision.

A number of film courses, both undergraduate and graduate, are offered by the Department of Radio, Television and Film, School of Speech, Northwestern University, Evanston, Ill. The School of Speech also offers a noncredit lecture series, which began Oct. 1, and includes the showing of 37 contemporary films. The lectures are grouped in four main categories showing the uses of film as entertainment, communication, education, and art. Thirteen courses are offered for credit. A course in Film Production offered during the 1958–1959 Winter session is a laboratory-lecture course which concentrates on film editing and sound recording.

The National Camera Report School, Box 174A1, Englewood, Colo., has been accredited by the National Home Study Council. The Council was organized in 1926 to set standards for home study schools. It has recently developed an accrediting program for home study schools which have been in existence for a minimum of five years and which meet certain standards.

Francis G. Semere has joined Thompson-Ramo-Wooldridge Products Co., 5500 W. El Segundo Blvd., Los Angeles 45, in the capacity of sales engineer. He was previously associated with Ramo-Wooldridge Corp. as industrial engineer. He has been active in the fields of electronic production, electronic research and development and automotive production.

Vin Agar has been appointed Western Division Manager of Natural Lighting Corp., 612 West Elk Ave., Glendale, Calif. During his 25 years of experience in photography and graphic arts, he has held the position of Vice-President of Sales of Watland Inc., Chicago, and has been in charge of reproduction and photographic services at Argonne National Laboratories. During World War II he acted as Medical Photographic Officer at the Armed Forces Institute of Pathology, Washington, D.C. Prior to his present appointment he was Head of the Graphic Arts Dept., Univ. of Calif., Berkeley, where he was in charge of all reproduction, still and motion-picture photography of the California Radiation Laboratory in Livermore.

A separate television service to supply overseas TV stations has been created within the U.S. Information Agency. Supplying documentary films, special events coverage, and features which depict various aspects of American life, this service will supplement American commercial TV activities. The USIA has noted that there are 560 TV stations overseas, 458 of them outside the Iron Curtain, and more than 20 million TV sets outside the United States and Canada.

Civil Service jobs are now open for motion-picture producer-director, script writer and editor, and film editor at salaries ranging from $4,980 to $9,890 a year. Most of the openings are in the Dept. of Agriculture and Dept. of the Navy in the Washington, D.C., area. A few positions may be filled in foreign countries. Detailed information is contained in USCSC Announcement No. 157B, available at most post offices or from the U.S. Civil Service Commission, Washington 25, D.C.

"It smells," long a term of disapproval, if not outright approbrium, may soon be used in an entirely different "scent" to describe the vital denouement (living end!) in motion-pictures. Rhodia Inc., the U.S. affiliate of Rhone-Poulene, a French chemical company, is cooperating with an organization called Weiss Screen Scent Corp. which, it is reported, will package a series of odors for installation in air conditioning systems in motion-picture theaters. The scent (odor) will be released according to a prearranged schedule to coincide with appropriate scenes being shown on the screen. The aim is to heighten audience identification by creating a mood. For example, Chanel No. 5 might be used for "high-society"-type romances and perhaps a lovely combination of tar and bilge-water for *On the Waterfront* type dramas.

The 25th Anniversary of the founding of Reeves Sound Studios, 304 E. 44 St., by its President, Hazard E. Reeves, was celebrated Oct. 3. The organization, originally located on Broadway, moved to its present location in 1947 and is now reported the largest sound service studio in the world. Several processes and corporations have derived from the firm's activities, including Reeves Soundcraft Corp. and Cinerama Inc. Mr. Reeves is also President of these corporations.

Marvin Schulman has been appointed Engineer in Charge of Maintenance and Remote Facilities for Television Station KCOP, Hollywood. He was formerly head of the Engineering Dept. of XETV, San Diego, Calif. and of KSHO, Las Vegas, Nev.

A series of 16mm color films called Navy Research and Development Film Reports, covering such subjects as new aircraft, missiles, submarines, ships and Marine Corps weapons, and other projects, is issued by the Navy Department chiefly for briefing purposes. Newsreel format is used in order to show individual projects at various stages of development. Additional information may be obtained from the Office of Naval Research, Code 109, Washington 25, D.C.

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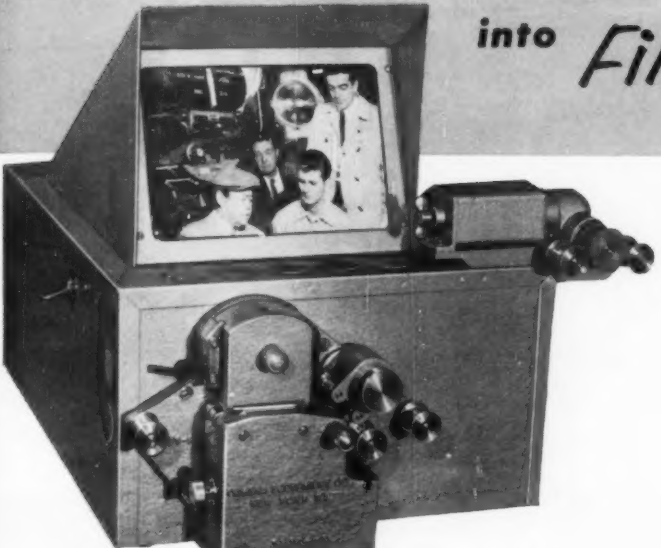

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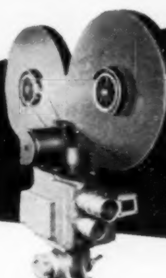

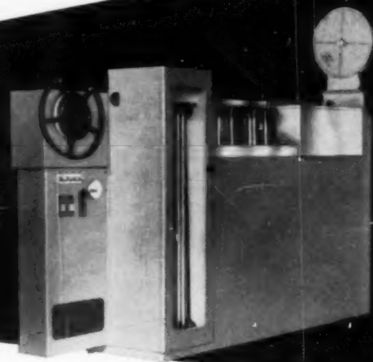

Auricon Cine—Voice Conversion

Cine—Voice Camera modified to accept 1200-ft, 600-ft, and 400-ft. magazines; has torque motor for take-up. Also includes Veeder footage counter and 3-lens turret. Conversion only—$450.00 less magazine.

R-15 FILMLINE Developer

Develops reversal and negative-positive film at 1200 ft. per hour. Has variable speed drive. Permits complete daylight operation. Exclusive overdrive eliminates film breakage.
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ON LAND...

Supervisor, Engineering Motion Picture Group, center foreground, directs Boeing motion picture crew as they photograph scene of Boeing test pilots inspecting the Boeing Model 707 Commercial Jet Transport for its first flight. Two Arriflex 16's and one Arriflex 35 are used.

UNDER WATER...

Boeing Motion Picture Unit Cameraman prepares to submerge with his underwater blimp into hydrostatic tank containing entire fuselage of Boeing KC-135 Jet Tanker. Photo in circle shows 16mm Arriflex camera mounted on platform of underwater case, especially designed and constructed at Boeing, to photograph the submerged fuselage.

AND IN THE AIR...

ARRIFLEX SERVES BOEING

T-33 pilot explains maneuver to Boeing cameraman before take-off.

Obituaries

Pierre M. G. Toulon

Pierre Toulon, 61, died July 22, 1958, at his home in Normandy, France. A member of the Society since 1947, he came to the United States in 1950 and in 1953 joined Westinghouse Electric Corp. where he engaged in research in the Television Section of the Electronics Dept. His primary interest was in the development of large flat screen picture displays for radar and television. Prior to his association with Westinghouse, he was Consulting Engineer for the Société Alsthom in France. He had been for 15 years Chief Engineer of Compagnie Française Thomson Houston. He held more than 150 French patents, mainly in the field of color TV and large area image displays. More than 50 U.S. patents were issued in his name and during his career at Westinghouse he wrote about 470 patent suggestions. His patent "Dot Interlace" is basic to the present color TV standards. Many of his ideas, such as that of ferroelectric control of the elements of a flat TV screen, are now being used as a basis for research by Westinghouse scientists. Shortly before his last illness he designed an electronic typewriter which displayed appropriate letters or numbers on an electroluminescent panel.

Charles Pathe

Charles Pathe, one of the early pioneers of the cinema and the founder of the largest French motion-picture firm, died December 27, 1957, in his 94th year, in Monaco, where he had lived in retirement for many years. Like many men of surprising destinies, Pathe was a visionary, a creator, but above all, an astute business man.

Charles Pathe was born in Vincennes, now a Paris suburb, on Christmas Eve, 1863. His parents were Alsatian, with a Danish heritage on his mother's side.

Long hours of work during his apprenticeship years were partially responsible for his poor health, causing many to believe that he was tubercular. This illness caused him to make frequent changes of employment with the result that his commercial flair did not evidence itself until 1888.

Pathe's prime goal was to be the proprietor of his own business, but lacking funds and with no exact idea to offer, he could find no one to back him. The result was that he had to take menial work in a lawyer's office. It was during his employment in the lawyer's office that he learned of a curious sound reproducing machine which was attracting unprecedented crowds at the Vincennes Fair. His inborn curiosity was aroused, and in later years he often told how he practically ran all the way to the Fair to witness a demonstration of this marvelous machine called a phonograph. This early cylinder phonograph was fitted with individual ear tubes so that a large group could listen to the then crude recordings for a fee totaling the small sum of two sous. Witnessing the rapt attention of the listeners, and rapidly calculating the machine's income possibilities, he left no stone unturned in his effort to find funds to purchase one of these early phonographs. His plan was to tour the provincial fairs then common in France, and exhibit it in more or less side-show fashion. Needless to say, his enthusiasm and good showmanship were fruitful, for on the first day he placed his machine on exhibition it earned for him more than 200 francs, which was greater than what he had earned in a full month's work in the lawyer's office.

The early phonographs aroused great interest in the rural areas, and it was not long before Pathe worked out an agency arrangement with the English manufacturers for the European distribution of their machine. He was soon swamped with business but found reserve energy to continually expand his activities. He not only opened stores for the sale of phonographs, but created his own recording studios.

Pathe was aware of the value of advertising and the ingenuity of his appeals brought him an ever expanding clientele. His recording studios quickly became known worldwide, as he attracted the leading orchestras, singers, monologuists and top entertainers of the day. In these early days there were no means for making a master sound recording and as a result each cylinder had to be recorded individually by the live performer. Pathe later wrote: "When I think about those hectic days which are not very long ago it seems as though it all happened on another planet." Pathe's meteoric rise began with the phonograph, and through his untiring efforts formed the foundation of his business success. He was soon to repeat his initial success with the Edison Kinetoscope, the ancestor of today's motion picture. It was natural that he should seize an opportunity to exhibit the Kinetoscope, as it provided an expansion of the phonograph's appeal to his already established audiences.

His promotion of the Kinetoscope almost duplicated his experiences with the phonograph, starting with a few machines and soon expanding their number to the point where film supply became a critical problem.

It was soon afterward that Charles Pathe persuaded his brothers to form a partnership for the further expansion of the Edison

Membership Certificates (Active and Associate members only). Attractive hand engrossed certificates, suitable for framing for display in offices or homes, may be obtained by writing to Society headquarters, at 55 West 42nd St., New York 36, Price: $2.50.

Kinetoscope. Unfortunately, difficulties arose soon after the partnership was formed, traceable to Charles' poor health and a clash of personalities. Brothers Jacques and Theophile withdrew from the partnership, leaving firm ties between Charles and Emile which were to last a lifetime. In 1897, Charles and Emile formed the Pathe Frères with a stated capital of 40,000 francs. Their letterhead, bearing the legend Pathe Frères, Phonographs and Motion Picture Machines (Phonographes et Cinematographes), was the first evidence of what was to follow.

Charles Pathe's early vision is confirmed by his announcement shortly after their partnership that: "The cinema will be the theatre, the newspaper, and the school of tomorrow."

The original Cours de Vincennes establishment was too far from the center of Paris, and with Charles' constant daring, the brothers opened their first central headquarters at 98 Rue de Richelieu — directly opposite their most serious competitor.

Until then the business was a mixture of success, poor accounts, litigation and fires, but while Charles Pathe was constantly driving toward the future, he could not secure the capital urgently needed for his expanding motion-picture production activities. This obstacle was surmounted in October 1897, when a Monsieur Grivolas entered the scene. Not only was this gentleman one of the the first movie enthusiasts, but one of Pathe Frères' wealthiest customers. M. Grivolas made available to the brothers the financial backing which would eventually enable their founding Pathe Cinema.

Their organizations were soon in full stride, requiring that Emile take over the phonograph recording and distribution business, while Charles was to apply his full attention to the cinema.

Pathe soon began the full-scale production of films which found a waiting market. His initial production was in the area of topical films which were the forerunner of the later newsreels. Seizing on happenings of the day, he simulated in his studio incidents such as: *The Sinking of the Martinique*, *The Dreyfus Affair*, *The Boer War*, *The Russian-Japanese War* and *The Assassination of Queen Draga of Serbia*, etc. And with them the world famous *Pathe Journal* was born. At first these films were made available weekly, but with almost instant public acceptance, he began *Pathe News* which in 1913 was issued on a daily basis. Pathe's cinema activities had almost a meteoric rise, requiring in 1899 that entire buildings be purchased to accommodate production and processing of films. Late in that year he was able to expand his laboratory production to 40 kilometers of film daily. In 1902, Pathe built the first fully equipped indoor motion-picture studio in France. This year also marks the date when Charles purchased the present location of the Kodak Pathe Company and he was soon to erect the first plant in France to manufacture motion-picture raw stock.

Pathe's vision and ready cooperation with his technical staff is confirmed by his segregation of the numerous divisions of his production facilities to avoid loss by fire which was always present in the then highly flammable nitrocellulose film.

The demand for the films produced by Pathe required constant expansion of his organization. He was quick to capture foreign markets, opening branch offices in England, Germany, Russia, Austria, Spain, Italy, Japan and in the U.S.A. Charles Pathe's production activities through the years covered every facet of the motion-picture art; raw stock manufacture, cameras, projectors, film processing, newsreels, the drama, adventure and science films, history, comedy and romance. Pathe's interest in the arts was evidenced in his founding the group known as Les Films d'Art (Art Films Company) to record for the masses the works of the masters.

In 1927, after a long series of negotiations with George Eastman, Pathe joined with him to found the Kodak Pathe Company of France. Finally in 1929, with the advent of sound motion pictures, Charles Pathe realized that the burden of years rested heavily on his shoulders and that he would not be equal to the tremendous task of starting all over again. Convinced that a younger generation was needed to make this challenging adventure a success, Pathe retired to the background at the peak of his prosperity, leaving to this younger generation a colossal company that still continues to grow.—*John B. McCullough.*


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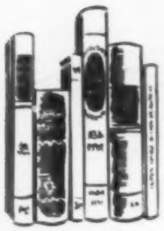


books reviewed

Engineering Economy (3d ed.)

By Clarence E. Bullinger. Published (1958) by McGraw-Hill Book Co., 330 W. 42 St., New York 36. 379 pp. Tables, graphs. 6 in. by 9 in. Price $7.00.

Professor Bullinger's book is intended to be used as a textbook.

The author's objective is explained in the Preface: "The engineer in industry has been accustomed to study problems assigned to him and to arrive at a functional design for their solution. More and more, the engineer is asked to participate in decision making by the study of the economic aspects of projects given to him for functional solution."

The author has observed that since World War II because of the effectiveness of operations research projects, management is expanding the study of engineering projects to include not only the technical or functional solution but also the economic solution. It is pointed out that management decisions include not only the functional feasibility analysis and the economic analysis which may be made by engineers but the intangibles and the necessary financial arrangements.

The textbook provides an engineer with the techniques of engineering project analysis necessary for an understanding of the economic aspects of projects. It provides a comprehensive coverage of all cost factors incurred from the conception of an idea through the development and design phases, to the design of the factory to produce it, and then the operation of the factory.

Material covered in this book is sufficiently condensed yet comprehensive enough to make it a valuable reference book for engineers engaged in the planning and design of products for manufacture. Project or design engineers who are familiar with the principles and techniques covered in this book are better equipped to integrate their product design activities with the planning of general management. An understanding of the economic factors will enable design engineers to consider many factors which have a bearing on the successful manufacture and sale of products, which they have a tendency to overlook, if they do not understand the overall problem of designing, manufacturing, and selling products profitably.—*M. C. Batsel*, Radio Corp. of America, Engineering Products Dept., Bldg. 10-7, Camden, N.J.

Technique of Film and Television Make-up

By Vincent J-R Kehoe. Published (1958) by Hastings House Publishers Inc., 41 E. 50 St., New York 22. 263 pp. Illus. 5½ by 8½ in. Price $9.00.

This book is the most thorough treatment on the methods of make-up, both black-and-white and color, which has come to this reviewer's attention. Here the amateur cinematographer can find clear, simple directions for glamorizing the girl next door, or the professional make-up artist can review the more complex procedures of making up for age, racial types or character delineation. I was especially delighted to find Mr. Kehoe stressing the important requirement for integrating make-up with lighting, wardrobe and set design.

Mr. Kehoe opens his book by building a firm foundation for his subject, explaining why make-up is used and what it can do. A consideration of facial anatomy and a comprehensive list of the tools of make-up are then presented, followed by detailed discussions of straight and corrective make-up, character make-up, and methods of creating the illusion of age. All of these discussions are well illustrated.

Problems of period and historical make-up are also considered with examples of how to make up Cleopatra, Julius Caesar, Helen of Troy or Attila the Hun, to name a few. Mr. Kehoe covers the fundamental differences from century to century, and even

shows the tricks of make-up for non-human types such as witches, devils or the animal men from *The Wizard of Oz*. Fantasy types such as fairies and elves, and even horror types such as Dracula and Frankenstein's monster are not neglected. And if you want to make up a pirate, or perhaps a clown, or even a doll, you are told how to accomplish that too.

An outstanding feature of the book is a discussion of techniques such as the making of face masks, prosthetic noses, eyes, scars, double chins and hair goods; and this is a how-to-do-it discussion, not merely a description of what should be done.

Mr. Kehoe is obviously an experienced make-up artist who knows what he is talking about, as a glance at his many and impressive credits clearly indicates. I consider his book a valuable addition to my library, and anyone interested in make-up will almost certainly find it interesting and useful. For a professional make-up artist it is a veritable handbook.—*Wilton R. Holm*, E. I. du Pont de Nemours & Co., Parlin, N.J.

Mr. Holm is Editor of SMPTE's Elements of Color in Professional Motion Pictures, *published in 1957.*

The Care and Conservation of Motion-Picture Film

By W. D. Korowkin. Published (1954) Fachbuchverlag, Leipzig, East Germany. 68 pp. 40 illus. 6 tables. 6 by 9 in. Paper bound.

The book conveys some elementary technical information and practical experiences, the knowledge of which is necessary to be a "progressive" projectionist in the Soviet orbit.

Listed as main characteristics, which influence the wear and tear of prints, are folding, abrasion resistance and shrinkage properties.

As a second set of requirements, to keep prints from being damaged and to obtain high quality theater performances, are mentioned adherence to the standards of film width, longitudinal and transverse pitch, film thickness and to a so-called checker-board-like displacement of the perforations (we call it squareness), given in this order of importance. It is interesting to note that size of perforations is not mentioned anywhere.

For gaging equipment the recommendations sound strange. Film width is to be measured at several locations of the print and at every splice, with calipers — to an accuracy of 0.0002 to 0.0004 in. Pitch uniformity and average pitch are supposed to be measured either with a comb-type gage, or a steel ruler. For more complete information it is suggested to use a gage. This last gage is manufactured by the "Workshop for Inspection Instruments" in Moscow. Film thickness is measured with a micrometer. Squareness error is established with the foldback gage. Its magnitude is determined with the aid of a grating in an eye loop.

The recommended protective treatment of prints consists of waxing, tanning or lacquering. Concerning lacquering, the book mentions that in spite of the many patents, this method is still not practical to use. It does mention, however, that at

present the "Scientific Research Institute for Cinematography and Photography" is trying to find a reasonable method for lacquering.

By inference it can be deduced that there are still a large number of nitrate prints in circulation. One remark lets one believe that recently about 20 tons of prints were destroyed within 3 minutes by fire.

Formulas of four recommended film cleaners are given. These are mixtures of carbon-tetrachloride, benzin, toluol and/or butyl alcohol.

The importance of not letting prints dry out, even in theaters, is emphasized at great length. It is requested that theaters keep the prints between performances in special storage cabinets at between 59 and 68F and 60 to 70% R.H. For storing color prints 65–70% R.H. and temperatures between 55 and 63F are requested.

Concerning the final use of prints, it was found under ordinary working conditions that progressive projectionists were able to project a print on stationary projectors 1,250 times, or 700 times on portable equipment, before any damage occurred. Contrary to this the "utilization standard of theater prints" is set at 600 for theaters with stationary equipment and 400 when used on portable equipment.

It is interesting to read this rather enlightening remark: "Occasionally damage occurs with qualified projectionists too. But that happens only when operation of the equipment was left to apprentices, which at the time, were not yet qualified to operate independently."

As main reasons for damage to prints are mentioned: (1) unsatisfactory surface conditions on projector parts; (2) improper tensions; (3) high rail and gate pressures; (4) defective rewinds; (5) faulty rewinding technique; and (6) lack of humidity.

The elimination of these causes will guarantee that the print will remain uninjured.

It is not permitted to show a print which was previously not checked. For that reason the exchange has to deliver the prints wound emulsion out with the start of the picture at the core end. With each print goes a "Print accompanying defect card." In case the check differs from the entries on this card, a report has to be made out in triplicate. In cities the report has to be signed by projectionist, technical leader and the manager of the house. In villages by the projectionist and by the Chief of the District Cine Department, or by a member of the "Collective Management." These reports then should be forwarded by registered mail, or special messenger to the exchange.

Special overhaul requirements of prints and projectors are listed:

The first-class splice should have a width of 0.08 in. and the second class 0.16 in. A good splice should withstand, 24 hours after it was made, a pull of 44 lb over its entire width.

Film tension in the projector gate should not exceed 300 to 350 g. On new or freshly overhauled projectors, oil should be changed after 20 hr. On old projectors the oil should be changed every 100 hr of operation. Internal inspection of the projector has to be undertaken every 200 hours.

When showing new prints the first time, film chutes with chamois or velvet inserts are to be used. The normal pulldown force on stock rolls should be between 60 and 100 g. When any worn parts are replaced on a projector, the new part should be broken in for 30 or 40 min. Then, if after 100 runs of a test loop, no mechanical defects or noticeable wear on the perforations, or on the surface of the test loop, are visible, the equipment can be released for use.

Concerning the protection of 16mm prints in the projector, the regulations are: After every 36,000 ft the projector has to be tested with a 5-ft long loop. The loop should be run 100 times and then remain free of streaks and scratches. When parts were changed, the projector should be broken in for 30 to 40 min. Then a 15-ft loop after 600 runs should not show any streaks or scratches.

On 16mm projectors the gate tension should not exceed 50 to 90 g. For a 360-ft roll of film, the unwind tension should be 15 g at the start and 50 g at the end of the roll. The take-up tension should be 50 g at the start and 10 g at the finish. For 1800-ft rolls, the unwind tension should average 100 g and the take-up 180 g.

The need for a planned preventive maintenance is greatly emphasized (even parts from a speech by Malenkov are quoted). Maintenance schedules are based on multiples of 550 hr of operation.

As was previously seen in Soviet publications, again it is pointed out how important it is for every projectionist to assume "certain specified socialistic duties" (which are to be checked daily by a superior). At the

monthly production discussions the fulfillment of these socialistic obligations will be judged and rated.

The last chapter of the book describes the duties of the "Technical Inspectors for Motion Picture Theaters" which is a government job. Their main task is to take action which will preserve film. Trips are planned so that each theater can be checked at least once every three months. When the performance average of the entire group of theaters is high, the work of the inspector can be rated as good. It is, however, not permitted to hide behind the average values, single, poorly performing theaters. The main task of the inspectors should be to improve these enterprises, which possess less good equipment and have less good services.—*E. I. Guttman*, Eastman Kodak Co., Kodak Park B.35, Rochester 4, N.Y.

The Technique of Stage Lighting

By Rollo Gillespie Williams. Published (1958) by Pitman Publishing Corp., 2 W. 45 St., New York 36. 198 (+ xvi) pp.; 71 black-&-white ill., 8 color plates, tables, index. $5\frac{1}{2}$ by $8\frac{3}{4}$ in. Price $7.50.

The recently published second edition of this standard reference work is notable for bringing up to date a wealth of technical and practical information. Although it is primarily concerned with stage lighting, film and television lighting engineers will find in it much useful material readily adaptable to their own craft.

The personality and background of the author give to the book its unquestionably authoritative nature. Mr. Williams has been for over twenty years one of Britain's and this country's leading theatrical illuminating experts gifted with an unusual artistic insight. He is the inventor of the stage lighting control system known as Rollocolor, and has collaborated on perfecting remote control electronic lighting systems (with Century Lighting Inc., New York).

The book is conveniently divided in four parts, enabling the reader to find quickly the desired section.

The first part deals with the scientific basis of illumination and provides important theoretical information for those concerned specifically with the use of stage lighting. The second part deals in detailed and thoroughgoing fashion with the design and layout of lighting equipment and installation.

Principles of an effective use of light and color in artistic composition are discussed in part three. Its value is derived mainly from the author's many years of successful experience in this field and his extensive contribution to research in the function of color as a dramatic element in staging.

The fourth part offers helpful practical advice for the theatrical producer, while keeping in mind amateur stage directors eager to give to their presentations that glossy professional touch.

Mr. Williams writes in a clear and unencumbered style. His discussion of aesthetics is never condescending to his reader and manages to retain an informal tone. On the technical side, his description of complicated equipment and its uses is thorough while avoiding unnecessary details. Illustrations are well selected and the color plates effectively used. A comprehensive index completes this interesting and useful book.—*George L. George*, Executive Secretary, Screen Directors International Guild, 507 Fifth Ave., New York 17.

TV Distribution Systems and Antenna Techniques

By Jack Beever. Published (1958) by Howard Sams Inc., Indianapolis 5, Ind. (Photofact Publication DSB-1) 167 pp. illus. $5\frac{1}{2}$ by $8\frac{1}{2}$-in. Paperbound. Price $2.95.

It is always a pleasure to read a text prepared by an expert in any field who in addition to his technical competence is able to express himself in readable English. *TV Distribution Systems and Antenna Techniques* falls into this category.

This book was written for the benefit of installers of television receivers and of multiple television systems. In consideration of this dual purpose the book divides naturally into two parts. The first five chapters contain discussions in elementary terms of the problems attendant upon the installation of efficient antenna systems. This material is of prime interest to anyone located at extremes of the service range of a broadcasting station. The last six chapters treat the problems attendant upon the distribution of signals from a single antenna to a number of receivers. The author discusses thoroughly both those passive (unamplified) systems which might be used in small apartment houses and motels and the more complicated systems that might be used to distribute signals throughout a single community.

This is a thoroughly practical text intended for the working man in the field.

It contains not more than a minimum of theory and probably would seem to be an abomination to the laboratory engineer.

There would seem to be some inconsistencies between tables T 15.5 and 15.6 for the attenuation of standard coaxial cables. It might have been wise for the author to have pointed out that the attenuation of such cables will stay within the figures quoted only if the material is bought on specifications.—*W. T. Wintringham*, Bell Telephone Laboratories, Murray Hill, N.J.

Elements of Magnetic Tape Recording

By N. M. Haynes. Published (1957) by Prentice-Hall, Inc., 70 Fifth Ave., New York 11. xii + 392 pp. illus. diagrams. $5\frac{1}{4}$ by 9-in. Price $7.95.

Elements of Magnetic Tape Recording is a readable, well-balanced book which assumes no previous knowledge of the subject. From this standpoint, and because it contains many "homely" analogies, it is an excellent volume for anyone who wants to start from the beginning, but does not want to become involved in advanced theory or in mathematics.

About one third of this book is devoted to magnetic recording principles and related subjects. The balance deals with practical aspects of magnetic recording, such as circuits, tape handling mechanisms, maintenance, editing, performance specifications, and typical commercial recorders.

Emphasis is on tape recording for audio. The specialized fields of sprocketed and synchronous recording as practiced by the motion-picture industry are not dealt with; neither are data recording, telemetering, computer, and similar nonaudio applications. However, an understanding of the basic principles of tapes, heads, circuits, and drives is useful also to those who work with special equipment.

The book includes a great deal of up-to-date circuit diagrams, servicing and operating procedure. It is recommended both for its easy-to-understand style, and for its practical coverage of equipment and techniques.—*Marvin Camras*, Physics Research Dept., Armour Research Foundation of Illinois Institute of Technology, 3440 South State St., Chicago.

Microphotography
Photography at Extreme Resolution

By G. W. W. Stevens. Published (1957) by John Wiley & Sons, 440 4th Ave., New York 16. i-xviii + 326 pp + 32 plates. Illus. $8\frac{3}{4}$ by $5\frac{3}{4}$ in. Price $8.50.

Only a dedicated person could have been the author of this book. For only such a one could have approached his subject with the meticulous attention to detail that is here displayed, and still have done so with a warm personal approach and occasional sly flashes of humor. The author states that, while most of his knowledge of the subject was gained while at Eastman Kodak Laboratories, some of his opinions may seem unorthodox and that the book should therefore not be regarded as having company endorsement. The author is to be commended for having transcribed accurately, or at least without a single factual error of which the reviewers are aware, the consolidated knowledge of many diverse sciences.

For the worker in the specific field of microphotography, the book provides an outstanding presentation of technique. One who has learned the material presented therein can truly claim to be a skilled craftsman. On the other hand, the instructions are so simple and direct that an amateur or hobbyist should be able to follow them and obtain creditable results. Some of the materials referred to may be difficult to obtain, but the author considers the effort to be justified. One of the reviewers has made a successful 3 by 4 mm copy of a newspaper page by a method which the author describes.

The usefulness of the book is not limited to the technician. In particular, the chapter on Microphotography as a Research Tool will be valuable to the physicist, chemist and biologist.—*Louis P. Raitiere* and *Bernard D. Plakun*, General Precision Laboratory Inc., Pleasantville, N.Y.

International Lighting Vocabulary of the International Commission on Illumination, Vol. I (2d ed.) contains 530 terms with definitions in French, English and German, as well as symbols and formulae. The book, prepared by a working party of the Commission Internationale de l'Eclairage

(C.I.E.), is intended to facilitate communication among scientists throughout the world who are working in the field of illumination. Volume 2 will be published in 1959 and will contain the same terms, without definition, in French, English, German, Danish, Dutch, Italian, Polish, Russian, Spanish and Swedish. A limited number of copies are available from U.S. National Committee, C.I.E., att. T. D. Wakefield, Treasurer, U.S.N.C., Vermilion, Ohio, at a prepublication price of $2.50.

Modern Geometrical Optics by Max Herzberger, published (1958) by Interscience Publishers, 250 Fifth Ave., New York, describes a system which enables modern lens designers to predict the exact performance of a lens, before making a single sample, by the use of a mathematical model. The system, developed during 35 years of optical research, reproduces all details in the optical image. Basically, the author reduces analyses of the lens image from varied errors to five simple types of errors for easier correction. Separate chapters deal with precalculation of optical systems and with the correction of color aberrations. Dr. Herzberger, who is internationally known as an authority on geometrical optics, is a senior research associate at the Kodak Research Laboratories, Rochester, N.Y.

A 56-page data book, *Eastman Motion Picture Films for Professional Use,* and specification sheets have been packaged together by Eastman Kodak Co. to provide comprehensive information on the proper selection of films for 35mm and 16mm motion pictures and procedures for obtaining the best results. The book contains information on the physical and photographic characteristics of various types of film and also discusses filters and processing. The package is available from Kodak dealers at a price of $1.25.

Closed-Circuit Television Systems, an RCA publication, is a 348-page book which explains the fundamentals and techniques of black-and-white and color closed-circuit TV systems. Characteristics and typical applications of various types of commercial equipment are described. Chapters are included on typical industrial applications and technical information prepared originally for the U.S. Air Force. The book is available from the Government Service Dept., RCA Service Co., Camden 8, N.J. It is priced at $4.50.

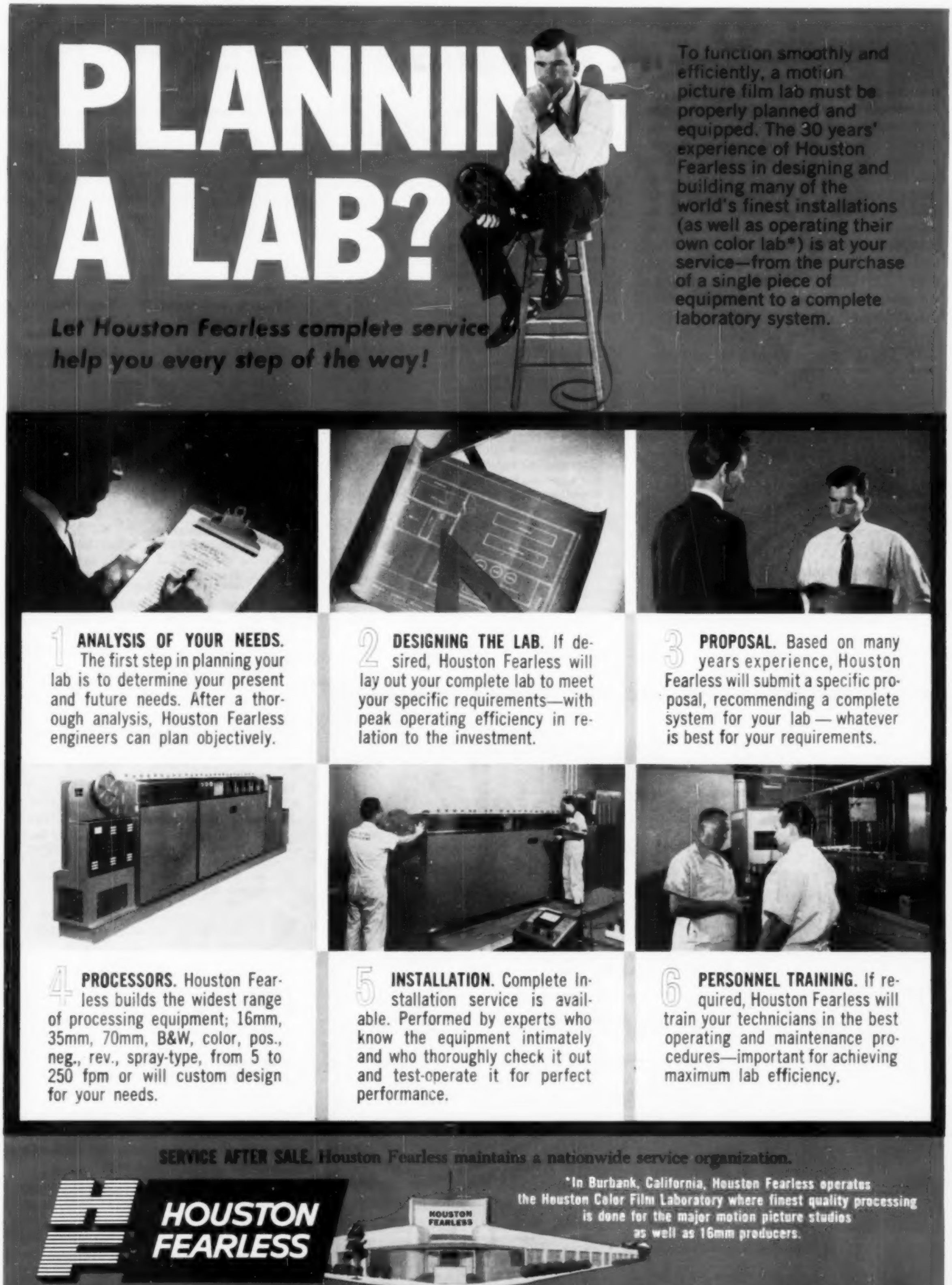
Magnetic Sound Recording for 16mm Motion Pictures, published by Eastman Kodak Co., is a 68-page booklet which describes the basic principles and techniques of magnetic sound recording and offers practical advice to users of magnetic sound-on-film equipment — such as business men, educators, industrial photographers and advanced amateurs. Sections in the book discuss basic equipment for making sound motion pictures, script preparation, camera techniques when shooting for sound, basic recording techniques, use of the microphone in recording, narrating, requirements of a recording studio, editing for and with sound, obtaining optical prints from magnetic sound films and care and handling of magnetic sound films. The book was written with the assistance of Prof. Glen Turner of Brigham Young Univ., College of Fine Arts. It is available through Kodak dealers at a price of 50 cents.

Selected References on Audio-Visual Publications (S-10), an Eastman Kodak publication, is highly recommended to anyone interested in the audio-visual field. Titles of books and articles on specialized fields, production, and projection and utilization with a brief description of their contents are included in the 28-page booklet which also lists general reference sources. Other Eastman booklets on audio visual subjects include *Foundation for Effective Audio-Visual Projection* (S-3), *Slides and Opaques for Television* (S-5), *Legibility Standards for Projected Material* (S-4), *Artwork Size Standards for Projected Visuals* (S-12) and *Making Black-and-White Transparencies for Overhead Projection* (S-7). These booklets are available without charge from Eastman Kodak Co., Sales Service Div., Rochester 4, N.Y. The request should include title and code number of the desired booklet.

The 27th edition of *Television Factbook* (Fall-Winter 1958–1959) is now available. Published semiannually by Television Digest, Wyatt Bldg., Washington 5, D.C., it is a standard reference work containing worldwide information on the TV industry. Included in the new edition is a complete list of the 3073 counties in the United States with the number of homes in each with TV and the percentage of saturation. The book is divided into approximately 70 sections which contain reference material on all areas of the television industry, including station ownership and personnel, equipment manufacturers, community antennas, consulting engineers, Congressional Committees, and many others. The 496-page book is priced at $5.00. A TV wall map, 34 in. by 22 in., showing cities and networks is included.

Kodak Pamphlet D-21, an 8-page booklet on *Getting the Most Out of Your 8mm Films,* tells the amateur cameraman how to use his films, how to handle the magazine and how to determine if it is half or completely exposed. The booklet also offers exposure and filter information. It is available without charge from Eastman Kodak Co., Sales Service Div., Rochester 4, N.Y.

Film en Televisie Gids Voor Nederland (*Film and Television Guide for the Netherlands*) published (1958) by Stichting Instituut Voor Filmdocumentatie, Amsterdam, has been revised and expanded from the 1954 edition of *Film and Television Guide for the Netherlands.* Although the book is in the Dutch language, it contains much of interest for readers unacquainted with the language. Considerable help is afforded by a five-language vocabulary, and the listing of the addresses of Dutch firms, producers, publications and associations is especially useful. The book is paperbound, 340 pp., and is illustrated.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Registered owners of the *Pocket Photo Data Book* will receive 18 pages of supplementary material without charge, according to a recent announcement by Morgan & Morgan Inc., Publishers, 101 Park Ave. New York 17. The pages, punched to fit the Pocket Photo binders, include changes and additions made in film and exposure data, etc., since the book was published early this year. The supplementary pages will also be included in new copies of the book. Planned as a guide to practical working data needed in general or studio photography, it is priced at $3.95 for the Standard Blue Vinyl binder edition, and at $4.95 for the Deluxe Cordovan Brown Vinyl binder edition.

Inter-Society Color Council has announced publication of *Bibliography on Color*. The 377-page volume represents the work of many years and many hands. The material has been assembled and arranged by Margaret N. Godlove from the bibliographies on color published in ISCC Newsletters during 1936–54 under the editorship of I. H. Godlove. Dr. Godlove had planned to prepare a subject index for this bibliography and at the time of his death some preliminary work had been accomplished. Mrs. Godlove, with the assistance of several Council members, carried on the project to its completion.

Priced at $3.75, the Bibliography may be ordered from ISCC-Godlove Bibliography, c/o Braden Sutphin Ink Co., 3650 E. 93 St., Cleveland 5.

current literature

The Editors present for convenient reference a list of articles dealing with subjects cognate to motion-picture engineering published in a number of selected journals. Photostatic or microfilm copies of articles in magazines that are available may be obtained from The Library of Congress, Washington, D.C., or from the New York Public Library, New York, N.Y., at prevailing rates.

American Cinematographer vol. 39, Jan. 1958
New Arri "35" 1000-ft Blimp (p. 30) *F. Foster*
The Science of Process Photography (p. 36) *J. Henry*

vol. 39, Mar. 1958
Dissolve-Lapse—New Technique in Interval Photography (p. 162) *L. Chaney*
A Practical Cine-Voice Conversion (p. 164) *B. Landrum*
A Report on High-Speed Infrared Film (p. 170) *B. R. Kantor*
How and When to Frame a Scene (p. 174) *J. V. Mascelli*
Zoom Lens for 16mm Cameras (p. 177) *J. Henry*

vol. 39, Apr. 1958
Dissolve-Lapse—New Technique in Interval Photography (p. 226) *L. Chaney*
Design Improvements in High-Wattage Filament Lamps Respond to Studio Needs (p. 228) *G. Howard*
Motion Pictures of "UFO's" *M. B. Miller* and *N. S. Kossuth*

vol. 39, May 1958
Syncing Camera With Tape Recorder (p. 302) *D. Blumgart*
Ten Methods for Making Color Prints (p. 304) *J. Henry*
Professional Titling With an Animation Stand (p. 306) *V. W. Palen*
Equipment for Filming UFO's (p. 309) *M. B. Miller* and *N. S. Kossuth*

vol. 39, June 1958
Theatre Screen Your Best Textbook If You Want to Learn Lighting (p. 364) *J. V. Mascelli*
Economy and Speed With Single-Double-System Sound (p. 372) *G. J. Yarbrough*

Bild und Ton vol. 11, Apr. 1958
Der 16-mm-Lichtton auf mehrschichtigem Farbfilm bei Behandlung nach dem Restsilberverfahren (p. 91) *O. Grabke*
Magnetische Bildaufzeichnung nach dem Ampex-Verfahren (p. 93) *K. O. Frielinghaus*
Die Breitwandwiedergabe (p. 95) *A. R. Schulze*
Proposed German Standards:
DIN 15 531 Rohfilmkerne
DIN 15 822 Doppel-8-Tageslicht-Aufnahmespule

British Kinematography vol. 32, Feb. 1958
Printing Motion-Picture Films Immersed in "a Liquid" (p. 40) *J. G. Stott, G. E. Cummins* and *H. E. Breton*

vol. 32, Mar. 1958
The Xenon Lamp for Film Projection (p. 59) *E. J. G. Beeson, W. A. Bocock, A. P. Castellain,* and *F. A. Tuck*

vol. 32, May 1958
Colour Kinescope Recording on Embossed Film (p. 123) *A. Tarnowski*
The Xenon Arc Lamp (p. 138)

Electronics vol. 31, June 20, 1958
Relay System Diplexes Audio and Color Video (p. 64) *T. G. Custin* and *J. Smith*

Film Technikum vol. 9, Apr. 1958
Optische Trick-Umkopiermaschine (p. 103)
Xenosol—die Xenonlampe von Zeiss Ikon (p. 104) *H. Ulffers*
Das Anamorphoten-Programm von Möller (p. 106)
10 Jahre Kinotechnische Fertigung bei Frieseke & Hoepfner (p. 108)

vol. 9, May 1958
Die Kinotechnische Industrie in Hannover (p. 138)
Rationalisierung im Filmtheater (p. 142)
FT-Gespräch mit Friedrich Wollenberg über das Thema Rationalisierung (p. 144)
Rationalisierung durch Vorführautomatik: [Die Wirkungsweise der Zeiss Ikon-Vorführ-Automatik (p. 148)

International Photographer vol. 30, July 1958
Mathematical Features of Various Motion Picture and TV Lenses (p. 9) *L. W. Physioc*

International Projectionist vol. 33, Apr. 1958
Basic Screen-Light Terms (p. 5)
New Micronic Light Control for Super Cinex Arclamp (p. 13) *C. S. Ashcraft*

vol. 33, May 1958
Machine Vibration and Image Steadiness (p. 5) *R. A. Mitchell*

vol. 33, June 1958
Optics of the Motion-Picture Projector (p. 5) *R. A. Mitchell*
Focus-Drift (p. 10) *J. J. Finn*

vol. 33, July 1958
Sprockets and Film Perforations (p. 5) *R. A. Mitchell*

Journal of the Audio Engineering Society
vol. 6, Apr. 1958

The "Stereosonic" Recording and Reproducing System (p. 102) *H. A. M. Clark, G. F. Dutton* and *P. B. Vanderlyn*

Kino-Technik vol. 12, Mar. 1958

Die Kinematographie als Zeit-Wegschreiber-Methode (p. 58) *J. Rieck*

Die Herstellung von Filmkopien im Flüssigkeitsbad (p. 61)

Der Einsatz von Transistoren in Tonfilmverstärkern (p. 65) *H. Thiele*

Entwicklungstendenzen im Bau von Schmalfilmprojektoren (p. 69) *H. Thiele*

Pariser Cinemathèque Française jetzt in neuen Räumen (p. 72)

vol. 12, Apr. 1958

Der 16-mm-Film im Berufseinsatz (p. 84) *G. Beissert*

Einsatz des Schmalfilms für Studium und Lehrzwecke (p. 90) *H. Weise*

Kameras und Projektoren für den 16-mm-Schmalfilm (p. 99)

vol. 12, May 1958

Die Fernseh—Grossprojektion erlangte Praxisreife (p. 118) *A. Narath*

Physik und Technik des neuen Eidophor—Projektors (p. 119) *E. Gretener*

Die Bedeutung des Eidophor-Verfahrens für Lehrzwecke (p. 124) *J. G. J. Metzner*

35-mm-Magnettonanlagen für mehrsprachige Wiedergabe (p. 126) *H. Lindemann*

Proposed German Standards (p. v–viii):

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DIN 15 560 Blatt 2 Kinotechnik: Stufenlinsenscheinwerfer für Lichtwurflampen—Stufenlinsen, Hauptmasse

DIN 15 557 Lichttonfilm-Wiedergabe: Verstärker für 35 - mm - Film—Richtlinien für die Bemessung von ortsfesten Verstarkern in geschlossener Einheit

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Ein Laufzeitgerät zur künstlichen Schallverzögerung (p. 191) *Hepper*

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A New Instrument for Testing Stereoscopic Vision (p. 1) *N. Bárány*

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Wide-Angle Image Forming Systems (p. 105) *N. Bárány*

Popular Photography vol. 43, July 1958

Photography in the Space Age (p. 51) *Lloyd Mallan*

PMI—Photo Methods for Industry
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Photography for Motion Analysis (p. 46)

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Processing Information on Digital Computers, *NBS Reference*

Tekhnika Kino i Televideniya, USSR
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New Developments in the Field of Filming Techniques (p. 6) *I. B. Gordiichuk*

On the Expediency of the Lengthwise Frame in Wide-Screen Cinematography (p. 16) *E. M. Goldovskii*

Characteristics of Television Cameras With a Double-sided Target (p. 37) *I. K. Malakhov* and *B. V. Krusser*

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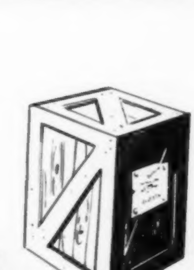
The Reactivity Characteristics of Non-diffusing Couplers With a High Activation Energy in Colour Development (p. 117) *S. P. Sharlandzhiev* and *V. S. Chelitsov*

The Use of the SKS-1 High-Speed Camera for the Photography of Distant Objects (p. 131) *G. I. Zubovskii, V. G. Latyshev* and *L. A. Novitskii*

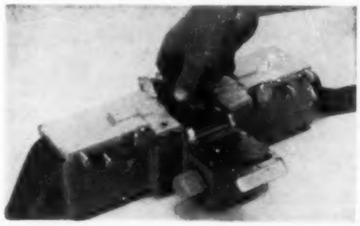
The Influence of Hypersensitization by Amines on Low-Intensity Reciprocity Failure (p. 136) *K. V. Vendrovskii* and *V. I. Sheberstov*

An Equation for the Solution of Problems Concerning Threshold Characteristics of Photographic Apparatus in Distinguishing Separate Objects in the Field of View (p. 138) *L. P. Moroz*



new products
(and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.



The Ampex Videotape Splicer has been announced by Ampex Corp., 934 Charter St., Redwood City, Calif. The splicer is a semiautomatic device which employs a

specially developed carbonyl iron solution called Edivue. The solution is used to make visible editing pulse marks which appear at ½-in. intervals along the bottom of the tape. The tape can be cut and spliced at one of the editing points. Exactness to $\frac{1}{40}$ in. is possible as the tape is played at the speed of 15 in./sec. There is a margin of safety of 1 in. as a cut can be made four pulses away from any indicated spot without noticeably affecting the picture. Designed especially for day-to-day use at local stations, the splicer is expected to be particularly useful in editing news events and commercials. Program requirements frequently call for cutting a commercial, for example, from 1 min to 30 sec.

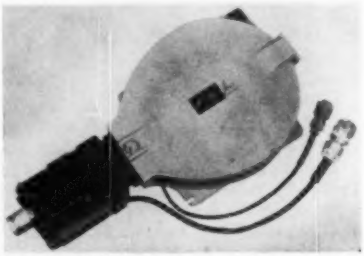
A splice kit, which includes the splicer, Edivue fluid, powder and pen, splicing and leader tape, and blades, is commercially available. The unit includes a shatter-proof glass shelf for mounting the splicer on a Videotape console. The complete kit is priced at about $780.00.

Papers from the three recent SMPTE Conventions are now planned for the November *Journal*. They will cover monochrome and color recording, interchangeability of recordings, conversion from monochrome to color, and splicing and editing.

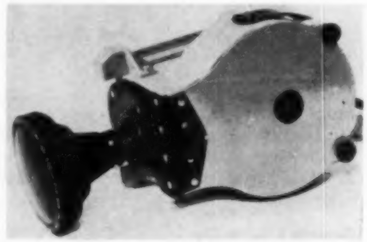
A dark tunnel, developed in the Santa Barbara, Calif., Laboratories of Raytheon Mfg. Co., for "outer-space" experiments, incorporates some interesting optical devices to simulate conditions to be encountered by space pilots exploring the uncharted regions between the stars. The tunnel, constructed by Raytheon for its own use, is 100 ft long, 24 ft wide and 8 ft high. This basic structure is divided into three separate 8-ft wide dark tunnels by partitions, which can be closed to conduct three separate experiments. If the use of a single 300-ft long dark tunnel is required, a series of four mirrors may be used to provide an optical path which passes through the three tunnels successively. This folding of the optical path is accomplished by using two mirrors 20-in. in diameter and two 12-in.-diameter mirrors. Each mirror is flat to within one fringe of sodium light across its surface.

For many experiments a 300-ft true path is insufficient. If required, an apparent extension of optical path is obtained through the use of an optical attenuator composed of one or two convex spherical mirrors of short focal length. A first order approximation of the attenuator operation may be obtained as follows: If, for example, the spherical mirror has a focal length of 1 in. and the source to be observed is 88 ft from the mirror, at the receiver, the angle subtended by the source image formed by the convex mirror will be reduced approximately as the square of the ratio of focal length to source distance. Except for mirror losses, the image has the same brightness in watts/centimeter. Therefore, placing the receiver at a distance of 5 ft from the mirror results in a flux density equivalent to that which it would receive if placed a mile from the original source. Similarly, with the receiver at 10 ft, the effective source distance is two miles. In the event that still larger attenuation or effective increase in source distance is required, two mirrors can be used in tandem — the second forming a reduced secondary image of the small image formed in the first mirror.

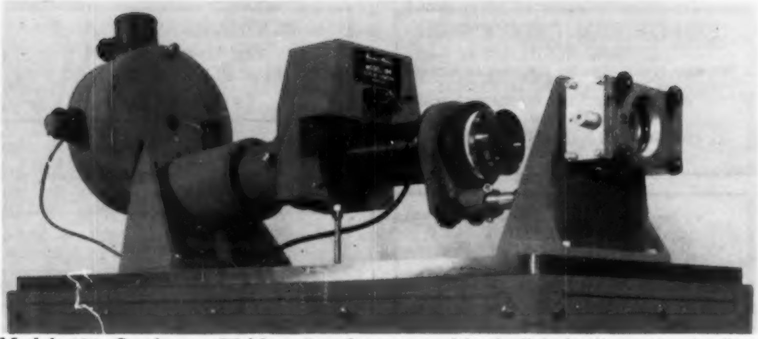
A new series of loudspeakers, 12-in., 15-in. and 18-in. Hi-C (high compliance) has been announced by Racon Electric Co., 1261 Broadway, New York 1, manufacturers of industrial and high-fidelity loudspeakers. Features include a plastic foam suspension between the cone and basket to provide high compliance and the resulting lowered resonant frequency. Prices are listed from $39.50 for Model 12-AW, woofer for 2-way or 3-way speaker systems; to $150.00 for Model 18-HW, a high compliance 18 in. woofer for cleanest low-frequency response.



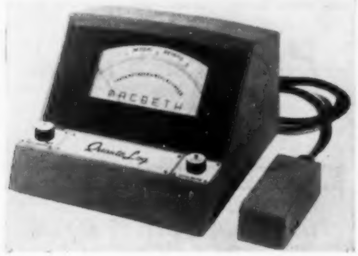
The Multidata M-3, a 16mm film magazine with 800-ft capacity, has been announced by Flight Research Inc., P.O. Box 1-F, Richmond 1, Va. Designed for use with its MOD III and MOD IIIB cameras, the magazine is designed to feed film for any camera speed up to 40 frames/sec in either cine or pulse operation without readjustment of the camera. The unit consists of a film transport, film chamber (stacked reel design), a drive motor assembly which mounts on the film chamber, and two daylight loading reels with removable flanges to accept film on standard raw stock core. A mounting plate adapts the camera for use with the magazine. Other features include an automatic cutoff switch and thermostatically controlled heater for low-temperature operation. The magazine weighs 9 lb 2 oz empty and 10 lb 11 oz when loaded with 800 ft of film. It is 10 in. high, 13 in. long and $4\frac{1}{16}$ in. thick.



A compact 16mm airborne instrumentation camera, called Traid 560 Fotomatic, has been developed by Traid Corp., 17136 Ventura Blvd., Encino, Calif. The camera, of stacked spool design, is 8 in. long, $5\frac{3}{16}$ in. wide and $6\frac{1}{4}$ in. high. It has a speed of 200 frames/sec, holds 200 ft of film on daylight loading spools, and, loaded, weighs $6\frac{3}{4}$ lb. It meets Mil Spec 5272A and withstands acceleration to 25 g. A 28 v d-c governor controlled motor provides continuous or intermittent operation. Shutter opening of 72° provides exposure

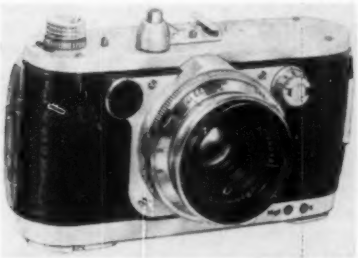


Model 194 Continuous-Writing Streak Camera, a product of Beckman & Whitley, Inc., 973 San Carlos Ave., San Carlos, Calif., produces a documentation which is a plot of space in one direction vs. time in a 90° direction. Designed to be a research tool for photo-instrumentation study of self-luminous transient events, the instrument is mounted on its own base and control housing. Standard 35mm film, arranged for daylight loading and unloading, is used. The image is swept onto this film by a rotating triangular mirror driven by a high-speed turbine. The maximum writing rate is approximately 8mm/μsec, total writing time at top speed, 58 μsec. Maximum time resolution, using a 0.004-in. wide slit image and film having a resolution of 75 lines/mm, is 2.5×10^{-8}. The record is approximately 18.5 in. long.



The Macbeth QuantaLog, a photometer designed for versatility and economy, has been announced by Macbeth Corp., P.O. Box 950, Newburgh, N.Y. The basic instrument is designed for ready connection to suitable attachments, some still in the process of being designed, which permit it to be used for densitometry, photometry and colorimetry. The unit features direct reading 0 to 4.0 density meter scale; accuracy of $\pm$.02 density units over the entire scale when used with the firm's Transmission Attachment or Reflection Head Attachment; low input of 25 w; full-scale sensitivity of 4.0 density with excitation of only 0.01 microlumens; and building-block design to facilitate connection of the various optical attachments. The two attachments mentioned are in production, and a digital readout attachment is being designed. The basic photometer has been announced as costing less than \$400.00 without attachments, described in the firm's Bulletin No. 287.

speed of $\frac{1}{1000}$ sec at 200 frames/sec. The camera is available with standard "C" lens mount or GSAP mount. Accessories include boresights, track finder, and various 16mm lenses including the Fotoperiscope lens assembly. Optional features include a timing system, output pulse installation, positive viewfinder with 3-objective turret and shutters from 7° to 204°.



The Robot Recorder, a 35mm camera designed for adaptation to various photographic registration applications, has been announced by Karl Heitz, Inc., 480 Lexington Ave., New York 17. The camera may be ordered with a kinographic mechanism for photographic sequence operations, at speeds up to 6 frames/sec. A built-in spring motor is incorporated for automatic film transport, shutter cocking and film counting. Available in 3 frame sizes, 36mm, 24mm and 18mm, it is priced at \$149.00 without lens.

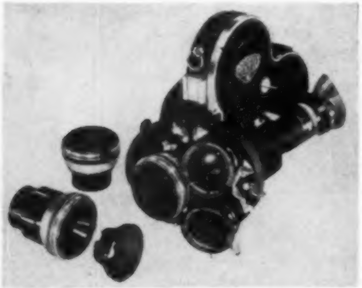
A 32-page booklet on photographic automation, "No: Register Photographically!" is available from Karl Heitz, Inc., describing the system and line of equipment by Robot-Berning & Co., Düsseldorf.

An addition to the Schott line of Interference Band Filters has been announced by Fish-Schurman Corp., 70 Portman Rd., New Rochelle, N.Y. The new filters are for the infrared spectral region from 1000–2000 mμ. Available in two types, Infrared Band Filters (IR-AL) and Infrared Precision Band Filters (IR-PAL), they are cemented to a suitable colored glass filter for absorbing transmission peaks of higher order. The location of λm is maintained with an accuracy of $\pm 1\%$ for type IR-AL and of $\pm 0.05\%$ for type IR-PAL. Maximum transmission of both types decreases with rising λm from about 50% at 1000 mμ to about 20% at 2000 mμ. Available in standard size of 2 in. by 2 in. or 50 mm diameter, the IR-AL is priced at \$60.00 and the IR-PAL at \$97.00. Special sizes can be made to order.

A lightweight television camera pedestal, designed by W. Vinten Ltd., especially for use with vidicon or other lightweight cameras, has been announced by Cinematograph Export Ltd., 715 North Circular Rd., London, N.W.2. Design emphasis is on maneuverability. A triangular base is mounted on three wheels interconnected with chain and sprockets. The camera pan and tilt head is mounted upon a central column and can be moved to a maximum height of 61 in. and to a minimum of 34 in., measured from floor level. The pedestal is capable of supporting weights up to 100 lb.

The NCE 35mm Viewer is a product of National Cine Equipment Inc., 209 W. 48 St., New York 36. Designed to combine in one unit the functions of viewer, synchronizer, footage counter and frame counter, it can be used with a sound reader for single-system or, with additional 35mm or 16mm sprockets, for double-system editing. Soundheads for magnetic tape can be added to additional sprockets for any number of magnetic tracks. Picture size is 3¼ in. by 4¼ in. The price is $595.00.

A trigger-grip handle which fits all Filmo 70 series cameras and is also available for the 240TA has been announced by National Cine Equipment Inc., 209 W. 48 St., New York 36. A tripod screw at the bottom of the handle holds the camera securely in place and a spring-loaded shutter release depresses a hook extension over the top of the Filmo Camera to release the regular camera button. It is priced at $29.95.



A new lens has been designed for use with Arriflex 16mm and 35mm cameras to permit continuous focusing from infinity to 4 in. Announced by Kling Photo Corp., 257 Fourth Ave., New York 10, as the 40mm $f/2.8$ Kilfitt Makro Kilar A, it weighs 6 oz and incorporates an unusually long helical mount to permit covering the extreme focusing range. *F*-stops from 2.8 to 22 may be pre-set to permit focusing with wide-open lens, and instant change to the selected *f*-stop for shooting. The price is $195.00. Illustrated is the 40mm $f/2.8$ mounted on Arri 16 turret, fully extended with lens-shade filter holder removed.

A camera stabilizer has been developed by Howard Dearborn Inc., 678 Front St., Berea, Ohio, to prevent unsteadiness resulting from use of the camera. Called the Dearborn Stabilizer, it is constructed of anodized aluminum tubing, fitted with compensating weights. The unit includes a titling glass which may be attached to the ends of the stabilizer at a recommended 20 in. from the camera lens, to be used for making background titles. The equipment has been marketed for makers of newsreels and industrial motion pictures.

Gossen photoelectric exposure meters and color temperature measuring devices are described in a 10-page folder available from Kling Photo Corp., 257 Fourth Ave., New York 10. The folder illustrates and describes meters ranging in price from the Dual-Sixon at $13.95 to the Sixticolor color temperature meter at $39.95.

Supplement sheets to the Sylvania Photolamp Technical Manual have been issued by Sylvania Lighting Products, 1740 Broadway, New York 19. The sheets describe the company's new interval reflector projection lamp and flashbulbs and include a Projection Lamp Index.

Bulletin No. 5 in the series of National Projector Carbon Bulletins has been issued by National Carbon Co., 30 E. 42 St., New York 17. The new bulletin discusses operating precautions and describes recommended procedures and techniques.

Information on filters suitable for Anscochrome and Super Anscochrome film when used under fluorescent lighting is offered by Ansco, Binghamton, N.Y. Although exact recommendations are not possible because of variations in fluorescent tubes and because reciprocity law failure may be a factor, the information is offered as a starting point for tests to be made by the photographer.

Lamps	*Tungsten Film*	*Daylight Film*
Soft white	10R + 30Y	10B + 30C
Standard cool white	40R + 30Y	10B + 10C
Daylight	50R + 50Y	10B
Standard warm white	10R + 20Y	10B + 30C
DeLuxe warm white	10R + 20Y	20B + 30C
White	20R + 20Y	20B + 20C

The Ampro Super Stylist 8, 10 and 12 series of 16mm sound film projectors is produced by Graflex Inc., Rochester, N.Y. The firm is a subsidiary of General Precision Equipment Corp. The Super Stylist 10 is reported of special interest to institutional audio visual users. It has a 10-w amplifier and a 10-in. Alnico 5 permanent magnet speaker mounted in the case cover. Features of the projectors listed are distortion-free amplifier; enlarged "bass reflex" type baffling chamber; triple claw movement; precision gear drive; and simplified threading.

The Brownie Scopesight Movie Camera, available in single-lens or turret model, has been announced by Eastman Kodak Co., Rochester 4, N.Y. Designed for amateur use, both models feature a built-in light meter coupled to an optical viewfinder; $f/1.9$ lens with full and half stops to $f/16$; multi-frame telescopic finder; and two built-in filters that can be flicked in and out of position. The single-lens model is priced at $79.50, and the turret model at $99.50.

A film editing outfit designed especially for amateur motion-picture photographers has been announced by Eastman Kodak Co., Rochester 4, N.Y. The package includes the new Kodak Movie Rewind, the Presstape Movie Splicer and one package each of 8mm and 16mm Presstapes. The outfit is priced at $13.90. The Rewind can be purchased separately for $6.95. It consists of a wire-form base and two rewinds that accept both 8mm and 16mm reels.

These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Photographic and Optical Engineer. Member of technical staff Bell Telephone Labs 21 yrs; Wollensak Optical Co. 4½ yrs; Fairchild Camera & Instrument Co. 3½ yrs. Familiar with practically every phase of engineering photography. Established primary techniques for complete photographic systems including film processing. Designed high-speed motion-picture and recording cameras. Developed new techniques for use in underwater, aerial, missile, industrial and research problems of motion analysis. Can lecture, sell. Author numerous publications and *Photographic Motion Analysis* (Industrial Laboratory Publishing). Served as consultant to many organizations. Fellow SMPTE and Royal Phot. Soc. Founded SMPTE High-Speed Committee and organized first International High-Speed Congress. Salary open. Will relocate. John H. Waddell, 33 Loretta Dr., Syosset, L. I., N. Y. Tel: WAlnut 1-5469.

Engineer-Photographic. Extensive experience in design and development of military and consumer opto-electro-mechanicals, photographic products and instrumentation. Capable of assuming complete responsibility from creative inception to acceptable prototype. Experienced in manufacturing procedures, design simplicity and parts interchangeability. Seeking project assignment or part-time engagement. Write: R.V.N., 59 New York Ave., Westbury, L.I., N.Y.

Cameraman. Have Bolex H16 equipment; will travel. Age 32. 10 years experience news, travel films, wildlife, etc. Go anywhere, anytime. Jack M. Sullivan, Offtrail Films, P. O. Box 86/3904 Sockwell Blvd., Greenville, Texas. Tel: GLadstone 5 2679/5 1424. Send for Confidential Service Bulletin #4.

Positions Available

Cameramen. Staff position. References and resume of experience required. Confidential. **Sound Technicians.** Experience, references. Permanent position. **Laboratory Technicians.** Timing experience. Permanent position. Write: I. C., 423 East 90 St., New York 28.

Electronic Engineer (Television Division). Qualifications: Engineering degree or equivalent; 3 yr general electronics and 1 yr television experience; extensive knowledge of vidicon and image orthicon monochrome and color systems, broadcast and closed-circuit systems, kinescope and video tape recording techniques and equipment, and microwave transmitting and receiving video and audio equipment. The incumbent of this position plans, designs, advises upon, coordinates, tests and evaluates development of television equipment, systems and facilities to determine their application in military service. Salary $10,130 per annum. Contact Miss Mary Jane Kerwin, Personnel Management Branch, Civilian Personnel Office, Army Pictorial Center, 35-11 35th Ave., Long Island City 1, N. Y. Tel: RAvenswood 6-2000, ext. 238.

Motion Picture Specialist. U.S. Civil Service Commission announces an unassembled examination for producer-directors, script writers and editors, and film editors for duty with Dept. of Agriculture, Dept. of the Navy and in a few foreign positions. Salaries $4,525 to $8,990. Complete details are in Announcement No. 157 B, obtainable from U.S. Civil Service Commission, Washington, D.C.

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News Columns

Advertisers

Meeting Calendar

84th Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 20–24, Sheraton-Cadillac, Detroit.

National Society of Professional Engineers, Fall Meeting, Oct. 23–25, St. Francis Hotel, San Francisco.

AIEE, Fall General Meeting, Oct. 26–31, Penn-Sheraton Hotel, Pittsburgh, Pa.

IRE, East Coast Conference, Oct. 27–29, Lord Baltimore Hotel and 7th Regiment Armory, Baltimore, Md.

EIA, IRE, Radio Fall Meeting, Oct. 27–29, Sheraton Hotel, Rochester, N. Y.

Aircraft Electrical Society, Equipment and Display, Oct. 30–31, Pan Pacific Auditorium, Los Angeles

IRE, Electron Devices Meeting, Oct. 30–Nov. 1, Shoreham Hotel, Washington, D. C.

IRE, Instrumentation Conference, Nov. 17–19, Atlanta-Biltmore Hotel, Atlanta, Ga.

Society of the Plastics Industry, Annual National Conference, Nov. 17–21, Morrison Hotel, Chicago

Society of the Plastics Industry, National Plastics Exposition, Nov. 17–21, International Amphitheatre, Chicago

American Rocket Society, Annual Meeting, Nov. 17–21, Hotel Statler, New York

American Standards Association, Ninth National Conference on Standards, Nov. 18–20, Hotel Roosevelt, New York.

Acoustical Society of America, Nov. 21–23, Chicago, Ill.

American Physical Society, Nov. 28–29, U. of Chicago & Hotel Windermere, Chicago.

ASME, Annual Meeting, Nov. 30–Dec. 5, Hotel Statler and Hotel Sheraton-McAlpin, New York

Electronic Industries Association, Conference on Reliable Electrical Connections, Dec. 2–4, Statler-Hilton Hotel, Dallas, Texas.

American Institute of Chemical Engineers, Annual Meeting, Dec. 7–10, Netherland Plaza Hotel, Cincinnati, Ohio

American Association for the Advancement of Science, Annual Meeting, Dec. 26–31, Sheraton-Park Hotel, Washington, D. C.

IRE, AIEE, EIA, American Society for Quality Control, National Symposium on Reliability and Quality Control, Jan. 12–14, 1959, Bellevue-Stratford Hotel, Philadelphia

Institute of the Aeronautical Sciences, Annual Meeting, Jan. 26–29, 1959, Astor Hotel, New York

Society of Plastics Engineers, Annual Meeting, Jan. 27–30, 1959, Commodore Hotel, New York

American Physical Society, Annual Meeting, Jan. 28–31, 1959, New Yorker Hotel, New York

85th Semiannual Convention of the SMPTE including International Equipment Exhibit, May 4–8, 1959, Fontainebleau, Miami Beach.

86th Semiannual Convention of the SMPTE including Equipment Exhibit, Oct. 5–9, 1959, Statler, New York.

87th Semiannual Convention of the SMPTE, May 1–7, 1960, Ambassador Hotel, Los Angeles.

88th Semiannual Convention of the SMPTE, Fall, 1960, Shoreham Hotel, Washington, D. C.

89th Semiannual Convention of the SMPTE, Spring, 1961, Royal York, Toronto.

90th Semiannual Convention of the SMPTE, Oct. 15–20, 1961, Statler, New York.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters, and of the Committee Chairmen and Members were published in the April 1958 Journal, Part II.

sustaining members

of the Society of Motion Picture and Television Engineers

Acme Film Laboratories, Inc.
Alexander Film Co.
Altec Service Company
  Altec Lansing Corporation
Ampex Corporation
Animation Equipment Corp.
Ansco
C. S. Ashcraft Mfg. Co.
The Association of Cinema Laboratories, Inc.
Atlas Film Corporation
Audio Productions, Inc.
The Ballantyne Company
Bausch & Lomb Optical Co.
Bell & Howell Company
Berndt-Bach, Inc.
Burnett-Timken Research Laboratory
Byron, Inc.
S. W. Caldwell Ltd.
Columbia Broadcasting System, Inc.
  CBS Television Network; CBS Television Stations; CBS News; CBS Film Sales; Terrytoons
The Calvin Company
Capital Film Laboratories, Inc.
Oscar F. Carlson Company
Century Lighting, Inc.
Century Projector Corporation
Cineffects, Inc.
Cinema-Tirage L. Maurice
Geo. W. Colburn Laboratory, Inc.
Color Reproduction Company
Color Service Company, Inc.
Comprehensive Service Corporation
Consolidated Film Industries
The Daven Company
Andre Debrie Mfg. Corp.
DeFrenes Company
DeLuxe Laboratories, Inc.
Desilu Productions, Inc.
Dominion Sound Equipments Limited
Du Art Laboratories, Inc.
E. I. du Pont de Nemours & Co., Inc.
Dynamic Films, Inc.
Eastman Kodak Company
Electronic Systems, Inc.
Elgeet Optical Company, Inc.
Max Factor & Co.
Fordel Films, Inc.
General Electric Company
General Film Laboratories Corporation
General Motors Photographic
General Precision Laboratory Incorporated
W. J. German, Inc.
Graflex, Inc.
Guffanti Film Laboratories, Inc.
The Harwald Co., Inc.
Frank Herrnfeld Engineering Corp.
Hollywood Film Company
Hollywood Film Enterprises Laboratory
Houston Fearless Company
Hunt's Theatres
JM Developments, Inc.
The Jam Handy Organization, Inc.
Jamieson Film Co.
The Kalart Company, Inc.
  Victor Animatograph Corporation
Kling Photo Corp. (ARRI Div.)
Kollmorgen Optical Corporation
Lorraine Orlux Carbons
J. A. Maurer, Inc.
  Precision Film Laboratories, Inc.
Mecca Film Laboratories, Inc.
Mitchell Camera Corporation
Mole-Richardson Co.
Motiograph, Inc.
Motion Picture Association of America, Inc.
  Allied Artists Products, Inc.
  Columbia Pictures Corporation
  Loew's Inc.
  Paramount Pictures Corporation
  RKO Radio Pictures, Inc.
  Twentieth Century-Fox Film Corp.
  United Artists Corporation
  Universal Pictures Company, Inc.
  Warner Bros. Pictures, Inc.
Motion Picture Printing Equipment Co.
Movielab Film Laboratories, Inc.
Moviola Manufacturing Co.
National Carbon Company, A Division of Union Carbide and Carbon Corporation
National Screen Service Corporation
National Theatre Amusement Co.
National Theatre Supply Company
Neighborhood Theatre, Inc.
Northwest Sound Service, Inc.
Panavision Incorporated
Pathé Laboratories, Inc.
Prestoseal Mfg. Corp.
Producers Service Co.
Radiant Manufacturing Corporation
Radio Corporation of America
Rank Precision Industries Ltd.
Reid H. Ray Film Industries, Inc.
Reeves Sound Studios, Inc.
Charles Ross, Inc.
S.O.S. Cinema Supply Corp.
Shelly Films Limited (Canada)
Southwest Film Laboratory, Inc.
The Strong Electric Company
Technicolor Corporation
Titra Film Laboratories, Inc.
Trans-Canada Films Ltd.
Van Praag Productions
Alexander F. Victor Enterprises, Inc.
Westinghouse Electric Corporation
Westrex Corporation
Wilding Picture Productions, Inc.
Wollensak Optical Company